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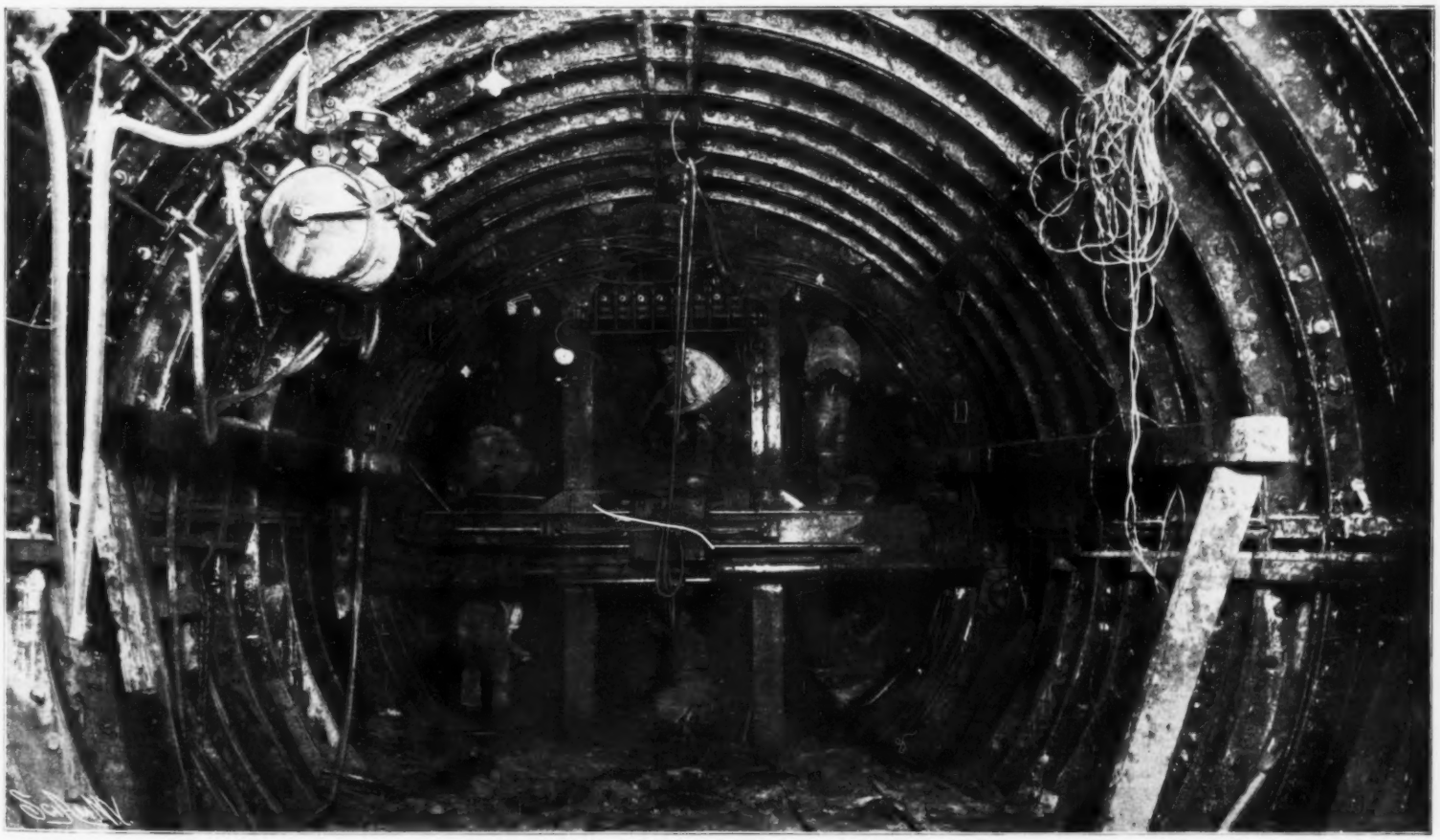
THE 17-FOOT 3-INCH SHIELD AT WORK ON THE GREAT NORTHERN AND CITY RAILROAD, ONE OF THE LONDON "TUBES," THE ERECTORS AND SEGMENTS ARE IN POSITION.



THE GREAT 24-FOOT 8½-INCH SHIELD AT WORK IN DIGGING THE TUNNEL STATION OF A LONDON "TUBE."

THE CONSTRUCTION OF THE LONDON "TUBES."

LONDON'S "TUBES" THE NOVEL METHOD OF THEIR CONSTRUCTION.

Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by our London Correspondent.

IN a few weeks' time a new deep-level "tube" railway will be opened for traffic in London, which is known as the Great Northern and City Railway, and which, when completed, will extend from Finsbury Park to Lothbury, a distance of 3¾ miles. The first section to be opened will be that extending from Finsbury Park to Moorgate Street.

Thus far three tube railways in London have been opened for traffic, and four more are now under construction.

The first underground tube railway in London was the City and South London, and the opening ceremony was performed by His Majesty the King (then Prince of Wales) in November, 1890. The line was formally opened for traffic on December 18 following. The second of London's tube railways was the Waterloo and City, opened in 1898, while the third, the Central London Railway, was opened for public traffic in July, 1900.

The four tubes at present in various stages of construction are:

1. Baker Street and Waterloo.
2. Great Northern and City.
3. Great Northern, Piccadilly, and Brompton.
4. Charing Cross, Euston, and Hampstead.

The rapid growth of London and the overcrowding of the streets was a subject which began seriously to agitate the citizens of the metropolis about the middle of the nineteenth century. The crowd of omnibuses, cabs, and vehicles of every kind made locomotion very difficult, and the only satisfactory method of solving the problem seemed to be by an underground railway. So long ago as the year 1846 Sir Frederick Bramwell proposed "the construction of subterranean railways in London, to be carried down into London clay, so as to secure a good stratum in which to work, and also a position below and clear of all the sewers and other matters situated a short distance beneath the surface."

The idea of a subterranean railway met with opposition and ridicule. Innumerable objections were raised and all kinds of imaginary evils were prophesied. Learned engineers, who had not taken to heart the admonition that we should never prophesy unless we really know, came forward and declared that the projected tunnel must of necessity fall in from the mere weight of the traffic, and the streets above; that the adjacent houses would be shaken to their foundation by the vibration caused by the engines, and that the families residing in them would be one and all poisoned by the sulphurous exhalations from the fuel with which the boilers were heated.

Gradually the majority of sensible people came to recognize the utility and possibility of the scheme, and in 1860 tunneling operations were commenced.

The difficulties of construction were many and formidable, but they were overcome, and on the 18th of January, 1863, the Paddington and Farringdon Street Underground was opened, the first sub-surface line in the metropolis.

The Metropolitan Railway was an instant success, 30,000 persons traveling over the line in the course of the opening day. The next session of Parliament saw the presentation of a vast number of bills for tunneling of London in all directions, and a committee of the two houses had to be appointed to take the whole of the metropolitan schemes into consideration.

On the first opening the underground railway extended only from Bishop's Road, Paddington, to Farringdon Street; but soon the line was extended so as to embrace an outer circle and an inner circle.

* Other subterranean lines in connection with the Metropolitan and District Railway companies' system were carried out, until the system had grown to its present size.

Turning now to the deep-level tubes, we have already mentioned that before very many weeks are over, a portion of the Great Northern and City Railway will be opened for traffic, namely, that between Finsbury Park and Moorgate Street.

The Baker Street and Waterloo Railway will be the next tube railway to be opened, while the next after this will be the Great Northern, Brompton, and Piccadilly Circus Railway.

A start has been made with the Euston, Charing Cross, and Hampstead Railway, but it will be many months before this is ready for traffic.

By the courtesy of various officials, contractors, and engineers, the writer has been afforded the opportunity of inspecting all these four tubes in process of construction, and in the present article it is proposed to point out the novel and most interesting features of each railway, and to show wherein each differs from another.

THE TUNNELS.

The Great Northern and City Railway presents many novelties. In the first place, the size of the bore of the tunnels is larger than that of any of the three tube railways at the present moment in operation.

The difference in the size is shown in the following table:

Tube.	Diameter of Tunnels. Feet.	Inches.
City and South London.....	10	6
Central London	11	6
Waterloo and City.....	12	.
Great Northern and City.....	16	.
Waterloo and Baker Street.....	12	.
Great Northern and Brompton....	12	7
Charing Cross and Hampstead....	12	7

The wide tunnels of the Great Northern and City Railway should do much to render the air more pleasant than it is on the tubes now open.

The question of ventilation has been much to the fore of late.

The Public Health Committee of the London County Council has recently reported on the conditions of the atmosphere of the Central London Railway, while others have, at various times, submitted it to analysis. While these reports do not give cause for much anxiety, it is evident that something might be done to make the air more pleasant, and to get rid of the peculiarly sickening atmosphere which the traveler encounters. The Central London Railway Company are establishing a huge electrical fan at Shepherd's Bush, which they expect will exhaust all the foul air in the tunnels in a very short space of time.*

THE COMPOSITE TUNNEL.

For the first time in the history of tube construction, the tunnels on the Great Northern and City Railway are of "composite construction."

So far all have been made of cast iron, but in the present case Mr. E. W. Moir, M.Inst.C.E., has devised a "composite" tunnel, viz., cast iron and brick, from which great things are expected, as it is believed that it will greatly diminish noise and vibration, and will give a more substantial and less elastic construction, and consequently less vibration than in the other tubes.

The multiple-unit system, which is being adopted on all electrical railways, whether underground or on the surface, will, of course, do much toward diminishing vibration.

Originally on the Central London Railway, electric locomotives were used. These brought about vibration, which was felt in houses above the tube; they have just been superseded by motor and trailer cars.

In the first part of the work executed on the Great Northern and City Railway, the tunnels were lined with iron, built up in segments 1 inch thick, with eight segments to the circle. These segments are 20 inches broad, measured in the direction of the length of the tube, and are bolted together through their inwardly projecting flanges by five 1-inch bolts on the sides, and by three 1-inch bolts on the ends. A key-plate, 12 inches wide, is used at the top, and the space between the segments and the clay wall is filled in with lime blown in the liquid form, on the system devised by the late James Greathead, inventor of the Greathead shield.

After about 4,000 feet in each tunnel has been constructed in this way, Mr. E. W. Moir, M.Inst.C.E., of Messrs. S. Pearson & Son, Limited, the contractors, decided to adopt the "composite" system, in which only the top half is lined with cast iron, the lower half being built in with a special brickwork in Bundle brick.

A cast-iron bearer plate is placed on the line of contact between the iron lining and the brickwork, so as to distribute the pressure evenly over the section face of the brick; the brickwork is 15 inches thick, and the bricks are capable of sustaining a pressure of 400 tons to the square foot.

STATION TUNNELS.

The running tunnel is throughout 16 feet in diameter, but the station tunnels are bigger. The biggest are at Moorgate Street, viz., 23 feet in diameter, and 475 feet long. All the other station tunnels are 21 feet in diameter, and 420 feet long.

THE SHIELDS.

The shields now used in tube railway construction are structures of steel, cylindrical in shape, provided with cutting edges in front. They are forced forward by powerful hydraulic rams, and are made in sections which are taken down the shafts and put together at the bottom.

The 17-foot 3-inch Shields.—The shields used for making the 16-foot running tunnel on the Great Northern and City Railway are 17 feet 3 inches in diameter, and are noteworthy in that the hydraulic pressure used (over 2½ tons per square inch) is greater, and the rams are more numerous, more powerful, and of considerably larger diameter than have hitherto been used in tube construction.

The 17-foot 3-inch shield cylindrical shell is composed of ½-inch steel plates swelted together with flush heads outside. It is built in six sections; its length from cutting edge to rear is 8 feet 9 inches. Round the cylindrical front are indented ten heavy cast-steel cutting edges, and two vertical and one horizontal bulkhead being forced by angle irons serve to stiffen the structure. The horizontal bulkhead projects about six inches beyond the cutting edge, and so helps to prevent any subsidence of the clay. The shield is divided into six compartments, each 4 feet wide, in each of which a man works on the face of the clay.

It is pushed forward by sixteen hydraulic rams or jacks, each bored out of solid ingot steel and 7 inches in diameter. The pressure has been as great as 2¾ tons to the square inch, and the rams escort their pressure directly onto the back of the cutting edge castings, and the purchase is taken off the edge of the erected tunnel segments nearest the shield.

Before each "shove" of the shield, the men excavate the clay with pickaxes and cut grooves in the face to a depth of some 18 inches; the shield is then driven forward and the excavated material is carried away on trucks hauled by ponies, and sent up the nearest shaft. The jacks are connected at the back to the hydraulic service, and the controlling valves are worked from one point on the back of the shield.

STATION SHIELDS.

The station shields are of two types. In the case of the Moorgate Street station they are 24 feet 8½ inches in diameter, and 9 feet 6 inches in length, with two vertical and two horizontal bulkheads, giving nine working compartments, and twenty-four 8-inch hydraulic rams.

The shields used for the other stations are 22 feet 10 inches in diameter.

THE ERECTOR.

The erector or hydraulic crane is employed for placing the cast-iron segments of the tunnel lining in position. In the case of the 16-foot tunnels one erector was used for erecting the cast-iron segments of the rings, but in the case of the larger shields two were used.

The erector is attached to the back of the shield at the center, so that its arm can sweep the whole periphery of the circle, while there is also an extending contracting motion radially: in the case of the smaller one the rotating motion is worked by means of a rack and pinion, the rack being moved to and fro by means of the hydraulic rams with stationary cylinders. The rack rotates the pinion about the main trunnion, and the latter is extended forward so as to form a box in which the extended arm slides, the extending motion being produced by another ram and cylinder bolted to the box.

The segments which go to make up the ring of the tunnel are built up within the tail of the shield, which always overlaps by 1 foot 8 inches or one cast-iron ring the last completed portion of the tunnel, so that the clay has no chance of pushing through into the tube. Eight segments and one key-piece go to make up one complete ring, and when these have been laid against the skin of the shield and bolted together the shield moves forward, leaving an annular vacuity 4 inches in width between the back of the plates and the natural ground. This space is made solid by the injection of grout under pneumatic pressure, by means of a cylinder or "bugee" orginally devised by Mr. Greathead. This consists of a closed cylinder in which lime and water are mixed together, till they attain the consistency of thick cream, by a horizontal spindle with arms which pass through it. Through the upper surface passes a pipe which conducts air, compressed to 40 pounds to the square inch, to the surface of the grout, which is conveyed through another pipe to the holes in the plates. Here it hardens, filling up any space there may be between the outside of the iron and the clay, and preventing any settlement of the ground above.

The length of the Great Northern and City Railway will be 3½ miles. At Drayton Park the line comes temporarily to the surface, but with this exception it is all underground.

The stations will be at Lothbury, Moorgate Street, Old Street, Essex Road, Drayton Park, and Finsbury Park.

As to the progress of the work, the maximum speed has been attained by erecting forty-four rings of the segments, completely bolted together and "grouted" during a week of 5½ days. The average is thirty-five to forty rings per week.

* The air-question of the London tubes has already been considered in these columns, for which reason a further discussion is deemed unnecessary.

THE EXPERT TRAIN DISPATCHER.

QUITE as scientific in its way as chess, and vastly more interesting, is the game of train dispatching, and fewer people are able to play it. The kings are the fast passenger trains rushing east and west laden with human lives. The queens are way passenger trains. The castles are fast freights. The pawns way freights. The board is a great stretch of country wherein are laid steel rails.

The game is played by memory by men skilled in the business. It is a game that takes much study for its mastery, and after its technicalities have been understood there are a legion of rules and regulations to be learned. It is a game of the head, in which alertness, a great memory, perfect clearness of intellect, and absolute attention are necessary. For this reason train dispatchers are not triflers. They deal with life and death every moment they are on duty, and in their hands is the destruction or preservation of a vast amount of property.

Trains are moved over railroads by time tables first, but accidents and delays make necessary their constantly being watched. This is the work of the train dispatcher. Because of an unusual amount of business of the same class it is necessary at times to divide certain trains into sections, and because of other reasons to create entirely new trains which do not fall into any of the prescribed classes. The regular trains, so long as they are "on time," move according to their schedules. When they are late they become subject in their every movement to the specific orders of the train dispatcher. And all special or extra trains and all sections of a regular train make no move except upon orders from the dispatcher.

All trains of a usual character fall into designated classes, and their movements on the great chess board are determined by their rights, which are specifically declared. First-class trains are fast passenger trains; second class, way passengers; third-class, fast freight trains; fourth-class, way freight trains, and so on. Frequently it occurs that some freight trains, because of their consignments (usually in the case of perishable goods or something ordered by the government for quick transportation), are made first-class trains by being entered by the dispatcher as a section of a regular fast passenger train.

To understand the value of a train this explanation is necessary: First-class east-bound trains have absolute right of track over all other trains on the time table. First-class west-bound trains have right over all except first-class east-bound trains. East-bound second-class have right over all except east and west-bound first-class. All west-bound second-class trains have right of track over all except east and west-bound first-class and east-bound second-class. All east-bound third-class have right over all except east and west-bound first and second-class.

There are probably at least 500 rules governing the movement of trains, and all train dispatchers, conductors, and engineers are required to know these thoroughly, and to pass a perfect examination on them before one or more examiners. These rules apply to almost every possible contingency that may arise in the business. There are broad and general rules relating to discipline; rules as to standard time, and the care and regulation of watches—much may happen in railroading in a minute or two, and all watches must correspond; rules as to time tables, signals, whistles, and flags; rules governing the classification of trains and their respective speeds, and many others.

The movement of trains by telegraphic orders from the dispatcher comes in for a number of complicated rules governing the direction, right of way, taking of sidings, clearance from stations, responsibility, protecting passenger trains, flagging, the use of torpedoes, crossing double tracks, and so on. Then there are special rules relating to the conduct of employes on almost every occasion, economy in running trains, the care of company property, the care of perishable freight

and of live stock, the comfort of human passengers, registering trains, and a hundred others, all necessary for the perfect movement of trains and a discipline of the system.

The chief part of the train dispatcher's business is the movement of trains by special telegraphic orders. Sitting in his office at the end of the division, his finger on the clicking key, his eyes glued on the train sheet, with its maze of thousands upon thousands of figures that indicate to him the whereabouts of every train on the line and their every movement, he sits during his "trick" of eight hours, not daring to permit any one or anything to divert his attention from his responsible work.

Now he sends a message giving a certain train permission to proceed to the next station; a moment later another contingency arises, and the order must be countermanded or "canceled," as the term is. Care must be taken not to get trains in one station with more cars than the sidings and main line there will hold. The "preferred" or high-class trains must not be delayed a moment. All these and many other things of equal importance the dispatcher must have constantly in mind.

He has no stenographer to transcribe his orders when he has figured out how he wants the trains to run; no operator to telegraph it; no clerk to make the entry on his train sheet. He does everything himself. There would be a division of the responsibility if the work were divided.

THE TRAIN SHEET.

The time table shows what the regular trains are supposed to do; the dispatcher's train sheet shows what they have actually done. The train sheets are made up by divisions, and the branches of each division, and have the names of the stations and sidings down the center, and two lines on either side, in which to record the time each train arrived at and leaves each station. Each sheet is started at midnight. On one side are east-bound trains; the other side is devoted to those west bound.

For all except regular trains, and for those regular trains that are not running on schedule time, special orders must be issued for each movement. The dispatcher does that. Studying the condition of the line from one end to the other, taking into calculation the class of the train, the size, (as determining her running possibilities), the rights of trains she might meet or pass, the necessity of keeping obstruction from the path of the through trains of a higher class, the capacity of the sidings, and mindful of an uncounted number of other essential things, the dispatcher sends the order directing the conductor and engineer what movement to make on the great board.

All special orders supersede the time table. The carrying out of orders issued by the dispatcher is imperative. Special orders have to do with positive meeting points of trains, time orders, right of track, work trains, orders to run ahead of regular trains as an extra, annulment orders (as, for instance, when a train is more than twelve hours late its number and original identity are taken away from it, and it is ordered to run as an extra), the running of trains in sections, the taking of sidings, and so forth.

On a positive meeting order each train goes to the designated station, and the first train there waits indefinitely for the other. Time orders give a train until a designated hour to make a certain station to wait for a train of a superior class. After the specified time has elapsed the superior train proceeds, while the inferior train, not having made the station, has had to lay back a station or two behind.

Time orders are generally given to passenger trains in order to help freight trains, as freight trains are uncertain. This prevents delay to passenger trains. Right-of-track orders simply reverse the rights as given by the time tables. For instance, if a dispatcher has one or more passenger trains of inferior rights on time he gives them right of track by special order over the delayed superior train, and the delayed train must then keep out of the way of the inferior trains that are on time.

Inferior trains may be given orders to run ahead of superior trains from one station to another. If a superior train is given an order to run an hour late all inferior trains are given one hour of the superior train's time—that is, all inferior trains receiving the order add one hour to their time as given by the time table, less five or ten minutes' clearance time that some trains are required to clear the time of others.

Special orders may contain one or more movements, and all trains mentioned or concerned must be given a copy of the order. All orders are sent to the telegraph office ahead of the train for delivery. The office that is to receive the order is called by the dispatcher. The dispatcher clicks "Copy three," or five, or seven, as the case may be, according to the number of trains that are to meet and should receive the order.

When the operator hears this he turns the train order signal which no train may pass, and says to the dispatcher, "Red displayed." The dispatcher then knows that the trains concerned are operating under their old orders and will be halted until his superseding order shall be given to them. Then he sends the new order from observation of his train sheet. He knows at the glance down and across the columns of figures where every train on the division is, and he knows, moreover, where every train will be at a given time, barring accidents.

The whereabouts of every train must be known. If a train has been running on schedule time, and its time at a certain station has passed, the dispatcher begins to think about it. He has noted on his train sheet that it passed the last station at 9:55 o'clock and is due at the next station at 10:06 o'clock. It is now 10:30 o'clock and the train has not been reported.

He calls up the station at which it is past due and asks for it. It has not been heard from. It evidently is in an accident. The minutes pass and soon he hears from the last station reported from. A brakeman has come in and reports a breakdown that will require an hour or perhaps more to repair. This necessitates special orders to following and meeting trains.

There are so many combinations against the calculations of the dispatcher that it is little short of marvelous that he is able to perform his duties with any degree of reliability. Engines break down at the most inconvenient times. When a passenger engine breaks down, the train must be supplied with the most available freight engine on the road, and another engine ordered for the freight train. A freight engine is a poor machine to pull a heavy passenger train. It cannot make steam because of poor coal, or its flues leak, perhaps its dump grates are down, or it does not carry enough water and must be cut off. Then it gets orders to run to the nearest water tank.

Maybe it breaks a side or main rod or blows out a cylinder head or slips an eccentric and must be run into the next station working only one side, and with half a train. Branch trains are delayed waiting for the connection. There is a bad piece of track here, a bridge under repairs there, and a broken rail somewhere else.

All these things must be covered with special orders to trains. This is where the dispatcher has to think with marvelous rapidity and accuracy. When a train dispatcher's day is done without accident, it has been a happy day. This does not mean that accidents are frequent, but that they may be in spite of close attention.—New York Times.

HIGH ACCELERATION ON ELECTRIC RAILWAYS: RESULTS ON THE LIVERPOOL OVERHEAD LINE.*

By HERBERT C. FYFE.

SIR WILLIAM FORWOOD, who presided at the last meeting of the Liverpool Overhead Railway Company, held the other day, made some interesting remarks concerning the results of the new high accelerative rolling stock which has quite lately been adopted on the line. Last year the directors obtained the sanction of the shareholders to a scheme for an accelerated service. Owing to delay in the delivery of machinery, the six-minutes accelerated service had only been in operation for a few weeks.

The result of the acceleration had been entirely satisfactory, for an average weekly decrease in earnings of £101 had been turned into an average increase of £72 per week.

The steps they took in the direction of acceleration (said Sir William) were so bold that electrical engineers, particularly Americans, predicted that they would not succeed and said openly that they were attempting what was impossible. He was glad to say they had realized everything they expected.

They were now running from end to end of the overhead railway, including all stoppages, at a speed of 19 miles an hour. Sir William gave in the following table, a comparison between the scheduled speeds with the new Liverpool equipment, and those obtaining on other lines.

	Miles per hour, Including Stops.
Liverpool Overhead Railway	19
Manhattan Elevated Railway	13½
Metropolitan Elevated Railway	14.1
South Side Elevated Railway (Chicago)	14.6
Lake St. Elevated Railway (Chicago)	12½
City and South London	13
Central London	14

From this table it will be seen that with regard to speed the Liverpool Overhead Railway is far in advance of anything yet attempted on an interurban railway. Like many other lines, the Liverpool Railway has been feeling severely the result of electric tramway competition, and the new accelerated service will assist the company very greatly in meeting this competition.

The North Eastern Railway are going to compete with the tramways by running petrol-electric motor-cars between Hartlepool and West Hartlepool and by electrifying some 40 miles of their suburban system.

The Lancashire and Yorkshire Railway are about to electrify their Southport-Liverpool lines, and it may be said that all the railway companies are considering the question of electrification and of accelerating and improving their present services.

Mr. James Holden, chief mechanical engineer of the Great Eastern Railway, has built a huge ten-wheeled engine for suburban traffic which will haul heavy trains at the highest possible speed between the stations, will start very rapidly, and will get up speed in very short time. This "decapod" will be able to attain a speed of 30 miles an hour in not more than half a minute from the time steam is turned on, and the result of placing such engines on the suburban services will be to greatly accelerate the speeds and improve the working of the vast traffic with which the Great Eastern Railway has to deal.

It will thus be seen that locomotive engineers believe that there is life in the steam engine yet, but we are of opinion that the adoption of "decapods" will only have the effect of a temporary relief and that the question of electrifying their suburban services will have to be carefully considered by the Great Eastern Railway before very long.

Keen advocates of electric traction have pointed out that electricity is the only motive power that can save the suburban steam line. They point out that the electrification of a suburban line while preserving many of the best features of railway work would strike at the heavy operating expense and give a more efficient, a speedier, and a cleanlier service. On one system where electrical trains have replaced steam locomotives, the cost of motive power has been reduced from 11.4d. to 6d. per mile, while the traffic on the system has increased by 400 per cent as the result of reducing fares, which was rendered possible by a more economical service.

An electric service substitutes for a number of steam engines scattered over a wide area one stationary engine plant, and it has been computed that steam locomotives for suburban traffic would consume 50 per cent more coal than a modern stationary-engine plant. While the tractive effort in steam locomotives rarely exceeds 16 per cent, it would range from 20 to 25 per cent on an electric system even where an electric locomotive was used, and every one knows that the multiple unit system is now the most favored.

The importance of high acceleration is now universally recognized, and it is with a view to improving their service in this direction that the Liverpool Overhead Railway—the first elevated line in the world to be operated by electricity—ordered a new type of electric equipment from Messrs. Dick, Kerr & Co., Ltd. The total length of the line is a little over 6½ miles with double track and a third feed-rail with a special-rail return operated by 500 volts direct current. The trains are made up of two and three carriages, the longer trains weighing about 55 tons.

With the original cars the entire distance was run in 32 minutes, including 16 stops, or practically at a scheduled speed of 12½ miles per hour. This required a minimum of 14 trains running at five-minute intervals. Messrs. Dick, Kerr & Co. guaranteed to run the whole distance, including 16 stops of 12 seconds, in 20.9 minutes, thus increasing the speed from 12½ to nearly 19 miles per hour.

The results of the new accelerated service are shown in the following table:

RESULTS ON THE LIVERPOOL OVERHEAD RAILWAY.

	Old system.	Accelerated service.
Mean speed	12⅛ miles (20 km.).	19⅛ miles (31 km.).
Number of stops	16	16
Mean time at stations	11 seconds.	11 seconds.
Mean distance between stations	729 yards (666 m.).	729 yards.
Watts per ton mile	110	157
Acceleration	1.6 ft. (0.44 m.) per sec. 2.	3 ft. (0.91 m.) per second per second.
Retardation	3 ft. (0.91 m.) per sec. 2.	4.8 ft. (1.26 m.)per second per second.

Such a rapid acceleration is possible owing to the excellent commutation of the motors, which will not spark when carrying 300 or 400 amperes, i. e., two or three times their normal current.

Each of the trains is now to be fitted with four 100 horse power of the new type designed by Mr. S. H. Short. Their efficiency is well over 90 per cent, and their weight is only 42 pounds per horse power. When the trains are all equipped with the new motors, 12 trains will be run instead of 14 as formerly, though the accommodation will be the same. With the previous equipment the train ran 144 train miles per hour; with the new they will run 216 train miles per hour. There was a five-minute headway between the old trains, but under the new *régime* they will be reduced to 3½ minutes. The total journey will now be made in two-thirds of the time taken on the old system, the load on the power station will be more uniform, and the machinery will be running under more efficient conditions.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

NEW MECHANICAL SINGING BIRDS.*

AT the request of the President of the Section, I will describe the singing birds constructed according to my new system. I will state how I gradually formed the idea of making these little automatons, and the researches and labor in realizing the modifications which distinguish these birds from those constructed at Geneva and other localities in past years, the manufacture of which has at times formed a prosperous industry. I will add a few words on the possible restoration of this industry, which disappeared from Geneva about a dozen years ago, in consequence of the decease of MM. Bruguier, its last representatives. It was in repairing one of their pieces, called bird snuff-boxes, that I first thought of constructing anew this class of mechanism, adding modifications capable of assuring the solidity and sureness of working, conditions essential for the durability and the facility for cleaning and repairing these delicate organisms.

It is not possible for several reasons to go into all the details by which I have obtained the end. My efforts have been directed to the simplification of several parts of the mechanism, for the purpose of obtaining a smoother wheel range, and making less noise in consequence of the motion of the last mobiles in the jewel holes. Other mechanical improvements have been introduced in certain parts of the movement. It is in consequence of this *ensemble* of qualities, that my birds were able to perform during the Exposition a large number of times (30,000 approximately) without any deterioration.

Another improvement relates to one of the most important organs of the musical part, the bellows, which is now constructed in such a way that the skin entering into its construction cannot be perforated by copper oxide, a serious inconvenience, frequently necessitating in the old apparatus difficult and costly repairs.

The other organs of the musical part, the flute for example, and the transmission of the movements to the bird itself, have also undergone modifications, which intensify the charm experienced by one observing the play and listening to the song.

The bird is not limited, as formerly, to turning always in the same way. Now, it appears slowly when the two parts of the cover are separated automatically. Its positions are varied, as well as its movements. Several times it gracefully inclines its head during its song, which it suspends and resumes after short intervals of silence. The song of the two birds now present is not the same. One represents the lark; the other, the white-throated warbler. Finally, its chant completed, the bird reposes again on its nest of satin, ready to reappear at the first call.

The horizontal closing of the cover allows of the bird being constantly in sight in all directions during its appearance. Various interesting modifications may be applied to the decoration of the boxes, increasing the variety. Indeed, in consequence of simplifying the caliber of the mechanism, the boxes are no longer restricted to the form and dimension of the old snuff-boxes, which still preserve in one of their sides a com-

* From the French of M. F. Cattelain. Communication to the Horological Section of the Society of Arts of Geneva.

partment for holding the powder so dear to the snuff-taker. They can be made of all sizes and receive the most varied decoration.

I will give rapidly my idea of what may be expected of the new manufacture, which, however, will require from one who undertakes it close application and thorough knowledge of the subject, though the execution of certain parts of the mechanism will be rendered easier in consequence of the progress realized in the manufacture of horological productions by mechanical processes; this is for the future. At present, I am obliged to make personally the tools suitable for this class of work, and execute by hand all the pieces of the mechanism actuating the movements of the bird, both in the interior of the box and within its body. I have been obliged to cover the bird with feathers of the humming bird, and to form its beak from a piece of ivory. With the exception of the decoration with enamel and gilding, I have been also obliged to prepare and finish the boxes themselves.

Under these conditions, there can be no extended manufacture at present. This will depend on the reception of the attempt in various countries. A favorable result may be hoped for if the attempt is pursued with perseverance and if, with the experience acquired at first, it is found possible to continue improvements of which it is susceptible.

From cork chippings, once thrown away, thousands of yards of linoleum are now made at Delmenhorst, Germany.

THE NEW CUBAN TELEGRAPHIC SERVICE.

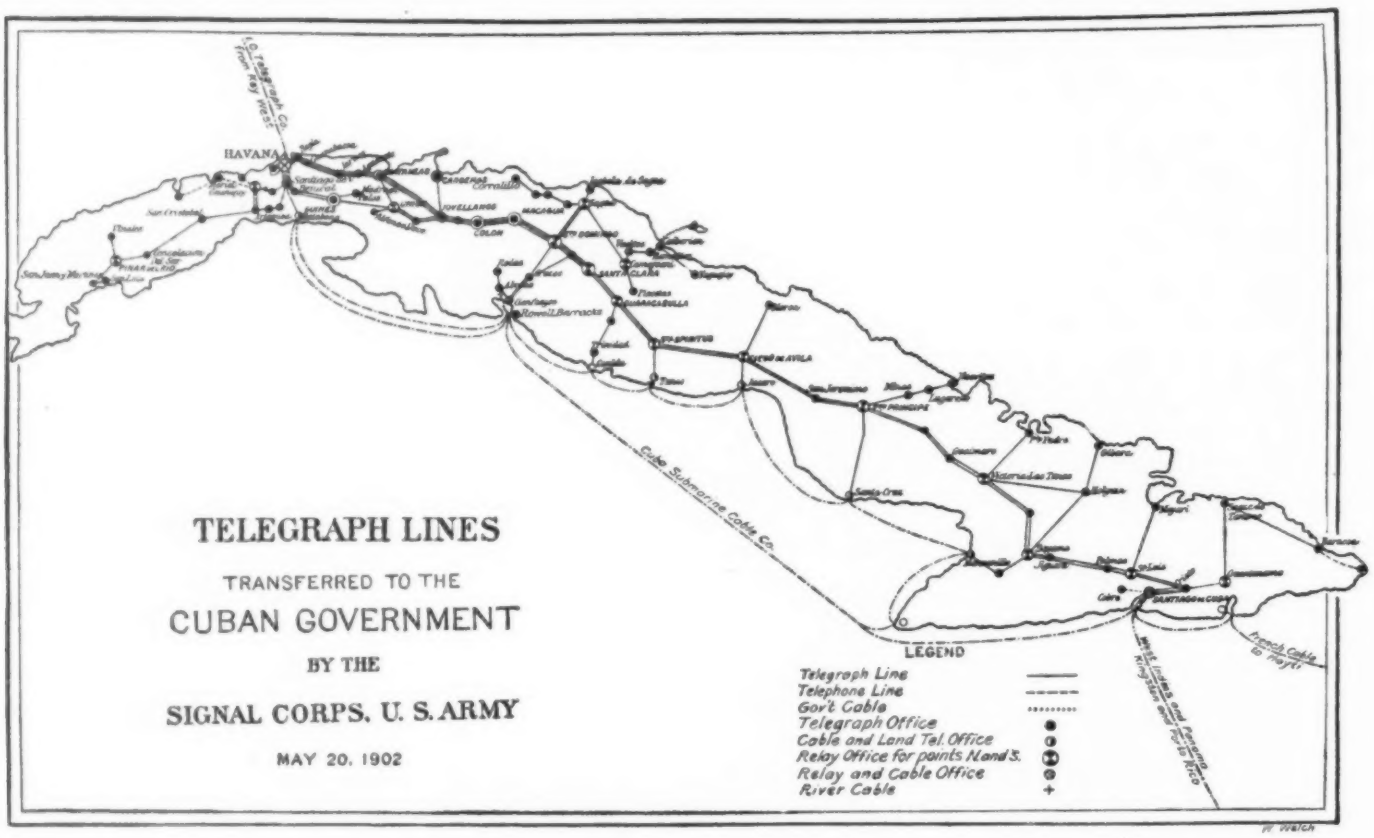
By CHAS. MINOR BLACKFORD, JR., M.D.

FEW factors in the civilization of our day are so important as the telegraphic service, and the efficiency of that service is an index of the development of a people. The Spanish rule in Cuba was not conducive to the highest development of the resources of the island, and the means of communication between its different portions were so poor that there was little or no traffic, even between the most important cities. This was true, not only in regard to roads and railroads, but the telegraphic system as well, for the latter was antiquated and inefficient, besides being extremely limited in extent.

When the island passed into American control in 1898, the telegraph lines were found to be in a most deplorable condition. In most of the provinces they were completely destroyed, either by the war or by sheer neglect, and in the provinces in which the lines were still operative, they were so much out of repair as to demand reconstruction. Under the Spanish government, the postal and telegraph services constituted a bureau known as the "Cuerpo de Comunicaciones," under the department of public works, and one of the first and most difficult tasks of the provisional government was to arrange for the separation of the postal service from the telegraphic, and provide for the reorganization of each on the plan pursued in the United States.

The signal corps of the army was assigned control of the telegraph system, and the burden of reorganization fell on it. The few lines in working order were not merely dilapidated, but were equipped with the old-fashioned open-circuit tape instruments that had been abandoned in the United States in the early days of telegraphy. The messages were relayed or handled at very short intervals, and the feat of sending a through message from Havana to Santiago had never been accomplished. The lines were often unserviceable for thirty hours or more at a time, and for all points east of Sancti Spiritus, a point that could rarely be reached, messages had to be sent over commercial submarine cables at a cost of from fifteen to thirty cents a word, according to the distance. The Continental instead of the American Morse was used, and the whole manner of operating and the general business management were at variance with the methods in use in the United States. The rates charged seem to have been designed to discourage the use of the lines by the public. For a telegram of ten words, including address and signature, twenty cents was charged, with an additional charge of five cents for each additional word, so that a ten-word message would be sent at a rate of two cents per word, whereas a twenty-word message would be four cents, and so on at an increasing ratio. Such a policy must have militated strongly against a liberal patronage of the government wires, and in fact, it reduced their use to cases of absolute necessity.

In anticipation of the military occupation, materials for the construction of 500 miles of telegraph line,



and 5,000 poles, had been collected by the signal corps of the United States army, at the supply depot established at Savannah, Ga. Thanks to this foresight and the energy with which the work was pressed, the overland trunk line between Havana and Santiago was completed by April 1, and on that day the Secretary of War, who was then in Santiago, sent the first message that had ever gone through between these points. It was addressed to the President, informing him of the opening of the line, and asking his congratulations for the officers who had superintended the construction. By June 3 the signal corps was operating 2,500 miles of telegraph lines, of which 600 miles was absolutely new, and most of the remainder had been reconstructed.

The work was steadily extended and improved, until the length of the wires in operation on the island amounted to about 3,500 miles, and the equipment was equal to any in the world. In addition, important points were connected by telephone, and every important seaport on the island was electrically connected. The government cables were repaired or replaced, and new cables laid where the best interests of the people demanded it. On May 20, 1902, when the military occupation ceased, there were 90 offices open for business, with 316 employes, of whom 144 were operators, 41 were messengers, and 109 were engaged in maintenance of lines. Eighty-two per cent of the employes were Cubans.

The best commentary on the improved service is the increased use made of it. At the end of the first six months, January to June, 1899, the commercial income amounted to $9,746.90, and the official business, estimated at commercial rates, amounted to $84,966.73. By June 30, 1900, the commercial business had increased to $57,712.13, and the official business to $134,974.86, and during the ten months from July, 1901, to May, 1902, the commercial receipts were $88,324.56, and the official work represented a valuation of $127,974.41. The figures are startling, and the highest praise is due to Capt. Otto A. Nesmith, United States Signal Corps, to whose skill and diligence this wonderful success is due.

[Continued from SUPPLEMENT No. 1441, page 23087.]

THE SCHROEDER CONTACT PROCESS OF SULPHURIC ACID MANUFACTURE.*

III. EXPERIMENTAL INVESTIGATIONS AND OBSERVATIONS.

By Dr. CHARLES L. REESE.

ALTHOUGH this process, from a chemical point of view, is an extremely simple one, yet the theory still

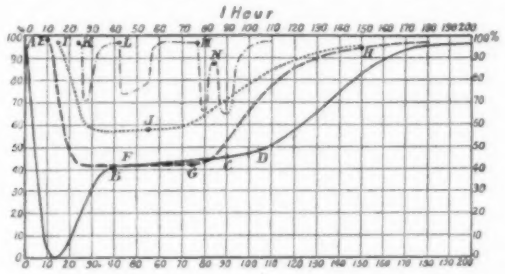

1 Hour
Effect of As. ——
A.—As2O3 put in entrance of tube.
B.—HCl passed in for 50 minutes.
C.—Air " " 15 "
D.—Resumed, passing SO2.
Effect of HCl. — — —
E.—HCl introduced continuously.
F.—Air passed in for 30 minutes.
G.—Resumed, passing SO2.
H.—Trace of HCl in exit.
Effect of Dry Cl. .....
I.—Dry Cl introduced continuously.
J.—Cl disconnected.
Effect of SiF4. —·—·—
K.—SiF4 introduced for 2 minutes.
L.— " " 1 minute.
M.— " " 3 minutes.
N.— " " 5 "

FIG. 1.

remains a mystery, shrouded in the word "catalysis." Another expression, sometimes used for the purpose of partially explaining the reaction, is "contact process," although I have never been able to satisfy myself that the acceleration of the reaction between sulphur dioxide and oxygen is accomplished by simple surface action.

After the very exhaustive paper read by Dr. R. Knietsch before the German Chemical Society in 1901, I shall confine myself to presenting the results of observations and experiments, most of which were made before Dr. Knietsch's paper appeared.

Purity of the Gas.—It is essential, for the continuous operation of the process, that the burner gas should be purified as far as possible, and that certain impurities be entirely absent.

The effect of the presence of the following substances in the gas on the efficiency of the contact mass has been observed:

Water, carbon dioxide, carbonic oxide, sulphur, hydrochloric acid, chlorine, silicon, tetrafluoride, arsenic, and lead. Some of these tests were carried out on a laboratory scale, with an apparatus which is practically a reproduction of the plant on a large scale, using a mixture of sulphur dioxide and air instead of burner gas; in some, the same apparatus was used with gas produced by burning pyrites.

Water.—It was thought at one time to be essential that the gases should be dried by sulphuric acid not weaker than 60 deg. B., but this was found to be an error, in that the gases could be saturated with moisture by passing them through water before introduction into the contact mass, without affecting the conversion in any way. Fuming sulphuric acid was produced, but, of course, such a procedure could not be carried out on a manufacturing scale, where it is necessary to use iron pipes.

Carbon dioxide had no effect whatever when introduced into the gas, as was to be expected, but I was surprised to find that carbonic oxide also had no deleterious effect in spite of its reducing properties. On one occasion the conversion in a certain plant ceased altogether, and we were at a loss to know the cause. We, however, soon found that some coal had got mixed with the pyrites in the burners. In this case there was carbon dioxide and, possibly, carbonic oxide present, but there was evidently also a lack of oxygen, and when the coal was consumed, conversion began again.

Sulphur will, at times, find its way through two or even three scrubbing towers, and, before the filtering

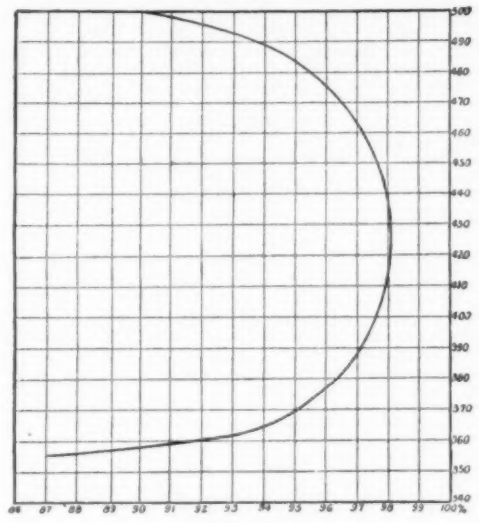


FIG. 2.

system was adopted, it became necessary to determine whether the presence of sulphur in the gas would effect the catalytic action of the contact material. Experiments were carried out to determine this point. It was desirable to introduce sulphur into the gas in as finely divided a condition as possible. This was accomplished by introducing hydrogen sulphide into the gas. When hydrogen sulphide is mixed with sulphur dioxide the reaction between these two gases takes place, producing sulphur and water, and sulphur was thus introduced into the mass. It was found that on discontinuing the introduction of hydrogen sulphide, the conversion continued to be normal, and the sulphur was simply carried through the tube. This experiment was repeated a number of times with the same result, showing that the presence of sulphur does not affect the reaction. Of course, hydrogen sulphide would affect it, in that it would reduce the sulphur dioxide.

The above substances do not affect the reaction of the contact mass, but hydrochloric acid, chlorine, silicon, tetrafluoride, arsenic, and lead do seem to affect it in two distinct ways: first, by their mere presence in the gas, and only when present in the gas; and second, affecting the catalytic property of the contact material. In the first case we have hydrochloric acid, chlorine, and silicon tetrafluoride. In the second we have arsenic and lead.

When hydrochloric acid gas is introduced, the effect is instantaneous, reducing the conversion from 98.5 per cent to 42 per cent; but when the hydrochloric acid is discontinued, and air passed through for a while to displace the hydrochloric acid, the conversion becomes normal in a short time. This is shown in Fig. 1.

The presence of chlorine in the gas seems to have an effect similar to that of hydrochloric acid, although not so intense, as will be seen in Fig. 1 by comparing the chlorine with hydrochloric acid curve. In both cases the dry chlorine or the hydrochloric acid was introduced, until a minimum yield was obtained, which, in the case of the hydrochloric acid, was about 42 per

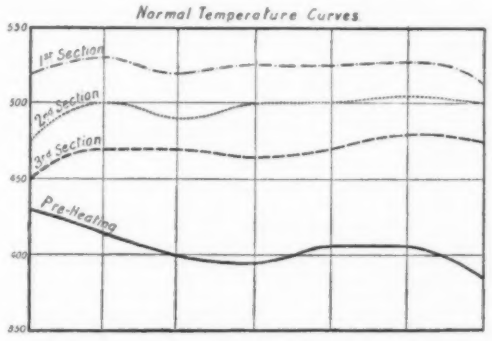


FIG. 3.

cent, and that of the chlorine, about 57 per cent. After disconnecting the chlorine and hydrochloric acid, air was passed through, and then the operation continued at the same temperature. As will be seen by the curve, the percentage conversion gradually rose again to the normal. Although at one point the gas showed a trace of hydrochloric acid, the conversion amounted to 94 per cent.

The introduction of a small amount of silicon tetrafluoride caused the conversion to drop immediately, but on discontinuing the silicon tetrafluoride, the conversion rose in a few minutes to normal. This was repeated a number of times, and a few minutes after the silicon tetrafluoride was disconnected, the conversion rose again to normal. In each case undoubtedly some silica was deposited on the contact mass, but most of it passed through the tube, as was made evident by the fact that silica separated out when the gas came in contact with the water solution used in testing the exit gas. Of course a minute quantity of silicon tetrafluoride in the gas would gradually deposit silica on the contact mass, and eventually cover the catalytic agent, so as to render it inactive; but when contact mass is so affected, it can be easily rendered active by simply removing it from the converter, and putting it back again. The handling will be sufficient to expose new surfaces.

The injurious effect of arsenic on the contact mass is extremely marked, as is shown in the curve in Fig. 1. Arsenious acid was placed in the front end of the tube, heated, and carried in to the contact tube by the flow of gas. The effect of the arsenic was to reduce the conversion absolutely to zero, owing to the large amount introduced, but after 40 minutes it rose again to 40 per cent. At this point hydrochloric acid was introduced for 50 minutes to remove the arsenic, and then air drawn through for 15 minutes more. The process was then continued, and the conversion rose to 96.5 per cent. Several attempts were made to find a simple means of removing arsenic from the contact mass, and at first chlorine was used for this purpose. The mass was placed in a tube, heated, and chlorine passed through. This did remove some of the arsenic, but did not regenerate the mass satisfactorily. A very interesting observation, however, was made during this experiment. It was found that the chlorine carried over platinum to the exit end of the tube, and deposited it in the form of chloride. This was done at a temperature of 400 to 450 deg.

It was found in attempting to regenerate or remove arsenic, that hydrochloric acid mixed with the reducing sulphurous gas was much more efficient, as is shown by the curve above referred to, all arsenic having been removed.

It is well known that, when platinum is heated in the presence of lead or lead salts, lead combines with the platinum either to form an alloy or a compound, and this combination of lead with platinum undoubtedly destroys the catalytic property of platinum. The effect of lead, however, was not determined in the regular way, but can be shown very readily by one or two simple experiments.

It is well known that when a platinum spiral is heated in a gas flame, the gas turned off for a few moments and on again, the spiral will reignite the gas. A small piece of contact mass will do the same, but if either is moistened with a very small quantity of lead acetate and then ignited, it will lose this property of reigniting gas, unless it is heated sufficiently long to volatilize the lead. A similar experiment will show in a rough way the effect of arsenic on contact mass, or on a platinum spiral.

The principal impurities which I have found in

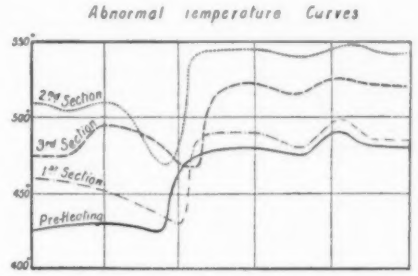


FIG. 4.

burner gases have been arsenic, lead sulphate, silicon tetrafluoride, hydrochloric acid, sulphur, and selenium. (I have not tested the effect of selenium or tellurium on the catalytic action of platinum.) All burner gases carry a mist which makes them visible, and which undoubtedly consists of finely-divided particles of sulphuric acid. This is extremely difficult to condense and separate from the gas. These particles also carry such impurities as arsenic, lead sulphate, sulphur and selenium. They cannot be separated by scrubbing, either with water or sulphuric acid, but contrary to Dr. Knietsch's opinion, they can all be removed by passing the gases through several layers of filtering material. After the filtering material becomes wet with the acid which is condensed in its interstices, the gas will pass out so free from solid or liquid impurities that a beam of sunlight from a lens cannot be seen when passed through a vessel containing the gas. When gas is purified to such an extent the contact mass will last indefinitely. Another simple test which shows the purity of the gas is to allow it to pass continuously through a tube containing absorbent cotton, when any acid or other impurity can be seen after a short time deposited on the cotton.

Temperature.—A series of experiments were conducted for the purpose of determining the most suitable temperature to which the gases should be heated, and at which the highest conversion could be obtained with the Schroeder contact material, and also to determine between what limits of temperature the process could be carried on commercially.

The results of these experiments are expressed in the accompanying curve (Fig. 2), in which it will be seen that the most suitable temperature is about 425 deg. C., but that there is very little variation between the results obtained at a temperature varying from 400 to 435 deg. Above and below these temperatures the percentage conversion drops at such a rate as to form a regular curve. The reaction starts at between 330 and 340 deg. C. My experience in testing impaired contact mass is that a higher temperature is required to start the reaction, and that this whole curve rises uniformly as to temperature. In fact, contact mass which has been very badly contaminated with arsenic and lead can be forced to act by raising the temperature up to about 530 deg., and, although the impurities are still in the gas, the conversion can be held up to between 85 and 90 per cent.

Although it seems to be necessary to control the temperature, in such processes as those in which platinized asbestos is used, by cooling, no such cooling is necessary with the Schroeder contact mass when used in sectional converters, other than that resulting from radiation. It is simply necessary to preheat the gas to

* Journal of the Society of Chemical Industry.

about 400 deg. C., and the converters will do the rest.

Some observations of the temperatures in the various sections of one of the converters are very interesting, and they show exactly where the major part of the conversion is taking place. The figures are plotted in four curves (Fig. 3), the ordinates of which represent temperatures, and abscissæ, time. It will be noted that the lower curve represents the temperature of the gas entering the converter; No. 1, the temperature of the gas leaving the first section; No. 2 the temperature of the gas leaving the second section; and No. 3, the temperature of that leaving the third section. (It is to be regretted that there was no thermometer in the top of the fourth section.)

It will be noted that there is a rise of more than 100 deg. C. in the first section, due to the heat of the reaction, and that the temperature gradually falls as it enters the successive upper sections, leaving the converter at a temperature below that at which it entered. About 85 to 90 per cent of the conversion takes place in the first section.

These curves I designate as normal curves. This particular set of observations were made several months after the converter had been put into commission, the readings having been taken with a new set of thermometers.

According to Dr. Knietsch's figures, it is possible that some dissociation takes place in the lower section, owing to the very high temperature attained, but as the temperature naturally falls as the gas passes through the upper sections of the converter to a temperature lower than the dissociating point of sulphur trioxide, any dissociation which takes place in the lower part of the converter will be cared for in the upper sections.

In the early days it was observed that as the contact mass in the lower section became contaminated, the maximum temperature rose to the second section, and so on, till the converter either refused to act, or was forced by raising the temperature in the preheaters to that represented by the maximum temperature under normal conditions.

The series of curves in Fig. 4 represent the temperature under abnormal working.

They represent a period of five days' running. It will be seen that on the first two days, with a conversion of 93.5 per cent, the preheating temperature was about normal, but the maximum temperature was reached in the second section rather than the first, but that some work was still being done in the first section. At the end of the second day the first section ceased acting, and it became necessary to raise the preheating temperature so as to bring the heat up to the second section when that again became more active, and the conversion was brought up to 94 per cent.

Absorption.—When sulphur trioxide is allowed to pass over or through water, it is not absorbed as completely as one would expect from the known avidity of sulphuric anhydride for water. Experiments have shown that when sulphur trioxide is passed over water, the rate of absorption increases as the strength of the sulphuric acid formed increases, until that strength reaches a point where its vapor tension is practically reduced to zero. In other words, the completeness of absorption increases as the vapor tension decreases, and when the acid in the system has practically no vapor tension at the temperature of operation, the absorption will be so perfect that the waste gas will be invisible.

If there is any acid in the absorbing system which has a vapor tension, sulphuric anhydride will unite with it, forming minute globules of sulphuric acid, which appear in the form of a cloud or mist, and when in this form it cannot be absorbed or condensed by acid of any strength, or even by alkali, satisfactorily. The only means by which I have been able to condense it is by forcing it through several layers of wet asbestos or cotton wool.

This fact can be readily demonstrated by the following experiment: pass dry gas containing sulphuric anhydride through strong sulphuric acid, and then weak acid, and no fumes will be visible, but if you pass the gas first through weak sulphuric acid, copious fumes will be formed, which will pass through any number of bottles of strong sulphuric acid.

TOTEMISM.*

By A. C. HADDON, M.A., Sc.D., F.R.S., M.R.I.A.

So much has been written of late on totemism that I feel some diffidence in burdening still further the literature of the subject. But I may plead a slight claim on your attention, as I happen to be an unworthy member of the Crocodile kin of the Western tribe of Torres Straits, and I have been recognized as such in another island than the one where I changed names with Maino, the chief of Tutu, and thereby became a member of his kin.

I do not intend to discuss the many theories about totemism, as this would occupy too much time; nor can I profess to be able to throw much light upon the problems connected with it; but I chiefly desire to place before you the main issues in as clear a manner as may be, and I venture to offer for your consideration one way in and some ways out of totemism.

A few years ago M. Marillier wrote ("Rev. de l'Hist. des Religions," xxxvi. 1897, pp. 368, 369), that "totemism is one of the rare forms of culture; it is incapable of evolution and transformation, and is intelligible only in its relations with certain types of social organization. When these disappear it also disappears. Totemism in its complete development is antagonistic alike to transformation or progress." In due course I shall describe how one people at least is emerging from totemism. At the outset I wish it to be distinctly understood that I do not regard this as the only way out; doubtless there have been several transformations, but a record of what appears to be taking place appeals more to most students than a guess as to what may have happened.

What is most needed at the present time is fresh investigation in the field. Those who are familiar with the literature of the subject are only too well aware of the imperfection of the available records. There are several reasons which account for this. Some of the customs and beliefs associated with totemism have a sacred significance, and the average savage is too reverent to speak lightly of what touches him so deeply. Natives cannot explain their mysteries any more than the adherents of more civilized religions can fully explain theirs. Further, they particularly dislike the unsympathetic attitude of most inquirers, and nothing shuts up a native more effectually than the fear of ridicule.

Language is another difficulty. Even supposing the white man has acquired the language, the vocabulary of the native is not sufficiently full or precise to explain those distinctions which appeal to us, but which are immaterial to him.

Granting the willingness of the native to communicate his ideas, and that the hindrance of language has been overcome, there remains the difficulty of the native understanding what it is the white man wishes to learn. If there is a practically insuperable difficulty in the investigator putting himself into the mental attitude of the savage, there is also the reciprocal source of error.

"Oh, East is East, and West is West,
And never the twain shall meet."

If Kipling is right for the civilized Oriental, how about those of lower stages of culture and more primitive modes of thought?

We must not overlook the fact that the majority of white men who mix with primitive folk are either untrained observers or their training is such that it renders them yet more unsympathetic—one might say antagonistic—to the native point of view. The ignorance and prejudice of the white man are great hindrances to the understanding of native thought.

When students at home sift, tabulate, and compare the available records they get a wider view of the problems concerned than the investigator in the field is apt to attain. Generalizations and suggestions crystallize out which may or may not be true, but which require further evidence to test them. So the student asks for fresh observations and sends the investigator back to his field.

The term "totemic" has been used to cover so many customs and beliefs that it is necessary to define the connotation which is here employed.

It appears from Major J. W. Powell's recent account of totemism (Man, 1902, No. 75) that the Algonkin use of the term "totem" is so wide as to include the representation of the animal that is honored (but he does not state that the animal itself is called a totem), the clay with which the person was painted, the name of the clan* and that of the gens,† the tribal name, the names of shamanistic societies, the new name assumed at puberty, as well as the name of the object from which the individual is named. He distinctly states, "We use the term 'totemism' to signify the system and doctrine of naming." I must confess to feeling a little bewildered by this terminology, and I venture to think it will not prove of much service in advancing our knowledge. It looks as if there had been some misunderstanding, or that the Algonkins employed the word "totem" to cover several different ideas because they had not definite terms with which to express them. Major Powell's definitions practically exclude those cults which are practised in various parts of the world, and which by the common consent of other writers are described as totemic.

Prof. E. B. Tylor has given (Man, 1902, No. 1; cf. Journ. Anthrop. Inst., xxviii, 1898, p. 138) the following clear exposition of his interpretation of the American evidence: "It is a pity that the word 'totem' came over to Europe from the Ojibwas through an English interpreter who was so ignorant as to confuse it with the Indian hunter's patron genius, his *manitu*, or 'medicine.' The one is no more like the other than a coat of arms is like a saint's picture. Those who knew the Algonkin tribes better made it clear that totems were the animal signs, or, as it were, crests, distinguishing exogamous clans; that is, clans bound to marry out of, not into, their own clan. But the original sin of the mistake of Long the interpreter has held on ever since, bringing the intelligible institution of the totem clan into such confusion that it has become possible to write about 'sex totems' and 'individual totems,' each of which terms is a self-contradiction. . . . Totems are the signs of intermarrying clans."

A reviewer in L'Année Sociologique, ii. 1899, says (p. 202): "One must avoid giving to a genus the name of a species. It will be said these are merely verbal quibbles; but does not the progress of a science consist in the improvement of its nomenclature and in the classification of its concepts?"

Totemism, as Dr. Frazer and as I understand it, in its fully developed condition implies the division of a people into several totem kins (or, as they are usually termed, totem clans), each of which has one, or sometimes more than one, totem. The totem is usually a species of animal, sometimes a species of plant, occasionally a natural object or phenomenon, very rarely a manufactured object. Totemism also involves the rule of exogamy, forbidding marriage within the kin, and necessitating intermarriage between the kins. It is essentially connected with the matriarchal stage of culture (mother-right), though it passes over into the patriarchal stage (father-right). The totems are regarded as kinsfolk and protectors or benefactors of the kinsmen, who respect them and abstain from killing and eating them. There is thus a recognition of mutual rights and obligations between the members of the kin and their totem. The totem is the crest, or symbol of the kin.

Sometimes all the kins are classified into two or more groups; for example, in Mabuiag, in Torres Straits, there is a dual grouping of the kins, the totems of which are respectively land and water animals; and in speaking of the latter group my informant volunteered the remark, "They all belong to the water; they are all friends." On the mainland of New Guinea also I found that one group of the totems "stop ashore," while the other "stop in water." When no member of a group of kins in a community can marry another member of the same group, that group is termed a phratry. An Australian tribe is generally divided into two exogamous phratries.

North America is the home of the term "totem," and though typical totemism does occur there, it is often modified by other customs. In Australia we find true totemism rampant, and it occurs in Africa, where also it is subject to much modification. Quite recently the Rev. J. Roscoe has published an important paper (Journ. Anthrop. Inst., xxxii. 1902, p. 25) on the Baganda, in which he describes a perfectly typical case of totemism. Among the Baganda there are a number of kins each of which has a totem, *muziro*. The kin, *kika*, is called after its totem; no member of a kin may kill or eat his totem, though one of another kin may do so with impunity. No one mentions his totem. Old people affirm their fathers found some things injurious to them either as food or to their personal safety, and made their children promise not to kill or eat that particular thing. No man may marry into his mother's kin, because all the members of it are looked upon as sisters of his mother; nor may he marry into his father's kin except in the case of two very large kins. In Uganda, royalty follows the totem of the mother, while the common people follow the paternal totem. Each kin has its own special part of the country where the dead are always buried. For sympathy or assistance the member of a kin always turns to his particular kin. From what Mr. Roscoe says about the married women of the Green Locust kin, it is evident that the magical aspect of totemism is present as it is in Australia and Torres Straits. The Baganda are thus a true totemic people who are in an interesting transitional condition between matriarchy and patriarchy. Totemic practices also occur in various parts of Asia.

To put the matter briefly, totemism consists of the following five elements:

(1) Social organization with totem kinsmen and totem symbols.

(2) Reciprocal responsibilities between the kin and the totem.

(3) Magical increase* or repression of the totem by the kinsmen.

(4) Social duties of the kinsmen.

(5) Myths of explanation.

Totemism is only one of several animal cults, and it is now necessary to consider certain cults that have been termed totemic before I proceed with the main object of this address.

MANITU (GUARDIAN SPIRIT).

Very widely spread in North America was the belief in guardian spirits which appeared to young men in visions after prayer and fasting. It then became the duty of the youth to seek until he should find the animal he had seen in his trance; when found he must slay and preserve some part of it. In cases when the vision had been of no concrete form, a symbol was taken to represent it; this memento was ever after to be the sign of his vision, the most sacred thing he could ever possess, for by it his natural powers were so to be reinforced as to give him success as a hunter, victory as a warrior, and even power to see into the future.

The guardian spirit was obtained in various ways by different American tribes, but the dream apparition was the most widely spread. Dr. Frazer ("Totemism," 1887, p. 2, 53) calls it "individual totem;" Miss Fletcher speaks of the object dreamed of (*the wahube* of the Omaha) as the "personal totem" or simply as the "totem;" it is termed by the Algonkin *manitu*, by the Huron *okki*, by the Salish Indians *sulia*, and *nagual* in Mexico. Perhaps it would be best to adopt either *wahube* or *manitu* to express the guardian spirit.

Miss Alice C. Fletcher finds that among the Omaha ("The Import of the Totem;" Amer. Assoc. Adv. Sci., Detroit Meeting, August, 1897) those who have received similar visions, that is, those who have the same *wahube*, formed brotherhoods which gradually developed a classified membership with initiatory rites and other rituals. These religious societies acquired great power; still later, according to this observer, an artificial social structure, the "gens," was organized on the lines of the earlier religious societies. Each "gens" had its particular name, which referred directly or symbolically to its totem, and its members practised exogamy and traced their descent only through the father. "As totems could be obtained in but one way—through the rite of vision—the totem of a 'gens' must have come into existence in that manner, and must have represented the manifestation of an ancestor's vision, that of a man whose ability and opportunity served to make him the founder of a family." Mr. C. Hill Tout (Trans. Roy. Soc. Canada, 2d ser., vii., sect. 2, 1901, p. 6), in discussing the origin of the totemism of the aborigines of British Columbia, states: "There is little room for doubt that our clan totems are a development of the personal or individual totem or tutelar spirit, as this is in turn a development of an earlier fetishism."

Dr. F. Boas points out ("Report U. S. Nat. Mus.," 1895 [1897], pp. 322, 323, 334) that the tribes of the northern portion of the North Pacific group of peoples, such as the Tlingit, Haida and Tsimshian, have a maternal organization with animal totems; the clans bear the names of their respective totems and are exogamous. The central tribes, particularly the Kwakiutl, show a peculiar transitional stage. The southern tribes have a purely paternal organization, and their groups are simple village communities which are often exogamic.

Dr. Boas distinctly asserts (l. c., p. 323) that "the natives do not consider themselves descendants of the totems; all endeavors to obtain information regarding the supposed origin of the relation between man and animal invariably led to the telling of a myth in which it is stated how a certain ancestor of the clan in question obtained his totem. . . . It is evident that legends of this character correspond almost exactly to the tales of the acquisition of *manitus* among

* Address before the British Association for the Advancement of Science.

* A group that reckons descent only through the mother.

† A group that reckons descent only through the father.

* The first intimation of this aspect of totemism is entirely due to the researches of Messrs. Spencer and Gillen ("The Native Tribes of Central Australia," 1899). Dr. J. G. Frazer, appreciating the value of these observations, extended the conception to totemism generally. Journ. Anthrop. Inst., xxviii. 1899, p. 285, read December 14, 1898; the Fortnightly Review, April, 1899, pp. 664, 665; cf. also "Israel and Totemism," by S. A. Cook, Jewish Quart. Review, April, 1902, pp. 25, 26 of reprint.

the eastern Indians, and they are evidence that the totem of this group of tribes is in the main the hereditary *manitu* of a family.* This analogy becomes still clearer when we consider that each man among these tribes acquires a guardian spirit, but that he can acquire only such as belong to his clan. Thus a person may have the general crest of his clan, and besides use as his personal crest such guardian spirits as he has acquired. This accounts partly for the great multiplicity of combinations of crests on the carvings of these people."

Throughout a considerable portion of North America there appears to be a mixture of variously developed cults of the totem and of the *manitu*. It is not perhaps possible at present to dogmatize as to the relative chronology of these two cults. Personally I am in favor of the superior antiquity of the totem cult, as the conception of an individual spirit-helper appears to me to be of a higher grade than the ideas generally expressed by purely totemic peoples, or what may be gathered by implication from a study of their ceremonies.

The social organization appears to be very weak in some California tribes; our knowledge of the Seri in this respect is very meager, but Dr. Dixon definitely denies (Bull. Amer. Mus. Nat. Hist., xvii., pt. 2, 1902, p. 35) the existence of totemic grouping among the Maidu.

Accepting then for the present the priority of the totem cult, we find a substratum of totemism underlying many of the social organizations in North America. Religious societies are a noticeable feature of the social life of Northwest America; those societies have the guardian spirit (*manitu*) as their central idea, but it appears as if the organization is rooted in a clan (matriarchal totemic kin) system which has been smothered and virtually destroyed by the parasitic growth. The problems to be solved in Northwest America are very complicated, and we must await with patience further researches. It is perfectly evident from the researches of Boas, Nelson, Hill-Tout, and others that comparatively recent great changes have taken place. Dr. Boas indeed states that "the present system of tribes and clans (of the Kwakiutl) is of recent growth and has undergone considerable changes" (l. c., p. 333). An interesting illustration of this is found in the alteration in the organization of the (Kwakiutl) tribe during the season of the winter ceremonial. "During this period the place of the clans is taken by a number of societies, namely, the groups of all those individuals upon whom the same or almost the same power or secret has been bestowed by one of the spirits" (l. c., p. 418). The characteristic North American idea of the acquisition of the *manitu* was evidently also fundamental among the Kwakiutl, as all their tales refer to it and the whole winter ceremonial is based on it.

I agree in the main with Mr. Hartland ("Folk-lore," xi. p. 68) in thinking that, "whether or no totemism was anciently a part of the tribal organization, the *manitu* conception is of modern date. It is part of the individualism which is tending, not among these tribes only, to obscure the older communistic traditions."

NYARONG.

Allied to the *manitu* of North America is the *nyarong*, or spirit-helper, of the Iban (Sea Dayaks) of Sarawak. The Iban believe that the spirit of some ancestor or dead relative may come to them in a dream, and this *nyarong* becomes the special protector of the individual. An Iban youth will often retire to some lonely spot or mountain-top and live for days on a very restricted diet in his anxiety to obtain a vision. This custom is called *mampok*. On the following day the dreamer searches for the outward and visible form of the *nyarong*, which may be anything from a curious natural object to some one animal. In such cases the *nyarong* hardly differs from a fetish. In other cases, as the man is unable to distinguish the particular animal which he believes to be animated by his *nyarong*, he extends his regard and gratitude to the whole species. In some instances all the members of a man's family and all his immediate descendants, and if he be a chief all the members of the community over which he rules, may come to share the benefits conferred by the *nyarong* and pay respect to the species of animal in one individual of which it is supposed to reside. "In such cases," Drs. Hose and McDougall remark (Journ. Anthrop. Inst., xxxi. 1901, p. 210), "the species approaches very closely the clan totem in some of its varieties." Here we have a parallel to the North American custom, but the later stages are not carried as far.

Personally I concur in the opinion expressed by Drs. Hose and McDougall that there is no proof that the peculiar regard paid in Sarawak to animals, the sacrifice of animals to gods or spirits, the ceremonial use of the blood of these sacrificed animals are survivals of a fully developed system of totem worship now fallen into decay. It is very significant that the magical and social aspects of totemism are entirely lacking.

Those who have read Miss Alice Fletcher's sympathetic account of "The Import of the Totem" (Amer. Assoc. Adv. Sci., Section Anthropology, Detroit Meeting, August, 1897) can scarcely fail to recognize that the moral support due to a belief in the guidance and protection of a *wahube* ("personal totem") is of great importance to the individual, and would nerve him in difficulty and danger, and thus proving a very present help in time of need it would surely justify its existence in a most practical manner and consequently be of real utility in the struggle for existence—a struggle which in man has a psychical as well as a material aspect.

The advantages of totemism are many, but most of them are social and benefit the special groups or the community at large. The hold that the *manitu* has on the individual consists in its personal relation; the man feels that he himself is helped, and I suspect this is the main reason why it supplants totemism. I believe Mr. Lang some years ago suggested the term *manituism* for this cult. If this name be not accepted I venture to propose the revival of the word "daimon" (*δαίμων*) to include the *manitu*, *nyarong* and similar spirit-helpers, and "daimonism" as the name of the cult.

THERIOMORPHIC ANCESTOR WORSHIP.

Dr. Frazer calls attention (Man, 1901, No. 3) to a publication by Dr. G. McCall Theal ("Records of Southeastern Africa," vii. 1901) in which he describes the tribal veneration for certain animals, *siboko*. The Bantu believed that the spirits of the dead visited their friends and descendants in the form of animals. Each tribe regarded some particular animal as the one selected by the ghost of its kindred, and therefore looked upon it as sacred. Dr. Frazer says: "Thus the totemism of the Bantu tribes of South Africa resolves itself into a particular species of the worship of the dead; the totem animals are revered as incarnations of the souls of dead ancestors. This entirely agrees with the general theory of totemism suggested by the late S. G. A. Wilken and recently advocated by Prof. E. B. Tylor" (Journ. Anthrop. Inst., xxviii. p. 146). But is this totemism? The *siboko* are the residences of the ancestral spirits of the tribe, not of a clan; there is no mention of *siboko* exogamy. Is this anything more than theriomorphic ancestor worship? There can, however, be little doubt that true totemism did occur, and probably universally so, among the Bantu people; but some of the tribes appear to be in a transitional state, and others have doubtless passed beyond typical totemism. The decay of the Bantu totemism in South Africa appears to have been mainly due to a patriarchal organization with a pastoral life.*

In describing Dr. Wilken's theory that the doctrine of the transmigration of souls affords the link which connects totemism with ancestor worship, Prof. Tylor concludes as follows: "By thus finding in the world-wide doctrine of soul-transference an actual cause producing the two collateral lines of man and beast which constitute the necessary framework of totemism, we seem to reach at last something analogous to its real cause." I have already expressed my belief that the animal cults of the Malay Archipelago, so far as they are known at present, cannot be logically described as totemism, and the majority of the peoples of this area have so long passed out of savagery that we are hardly likely to find here an unequivocal clue to the actual origin of totemism.

The reverence paid to particular animals or plants by certain groups of people in Fiji may, as Mr. Lorimer Fison says, ("Ann. Rep. Brit. New Guinea," 1897-98, p. 136) "look like reminiscences" of totemism, but he has "no direct evidence." It surely belongs to the same category as the Samoan custom of which Dr. George Brown writes (*ibid.*, p. 137): "In Samoa every principal family had some animal which they did not eat, and I have always regarded this as meaning, not that they thought the animal divine, or an object of worship, but that it was the 'shrine' in which their ancestral god had dwelt, or which was associated with some fact in their past history which had led them to adopt it as their totem." An opinion which Prof. Tylor has independently expressed (Journ. Anthrop. Inst., xxviii. p. 142), but he naturally dissents from the incarnate god being termed a "totem."

I agree with Dr. Codrington ("The Melanesians," 1891, p. 32) in doubting whether the evidence warrants a belief in totemism as an existing institution in the Southern Solomon Islands. I suspect that totemism has been destroyed over a considerable portion of Melanesia by the growth of secret societies as well as by theriomorphic ancestor worship. Herr R. Parkinson (Abh. Ber. k. Zool. Anth. Eth. Mus. Dresden, vii. 1899, Nr. 6), however, proves true totemism in the Northern Solomon Islands as the Rev. B. Danks had previously done (Journ. Anthrop. Inst., xviii. 1889, p. 281) for New Britain, Duke of York Island, and New Ireland.

The more one looks into the evidence the more difficult is it to find cases of typical totemism; almost everywhere considerable modification has taken place, often so much so that the communities cannot logically be called totemistic. The magical increase of the totem by the clansmen does not appear to be common, but that may be due to its having been overlooked; on the other hand, magic may be performed against the totems to prevent them from injuring the crops, as in the case of the "Reptile people" of the Omaha (J. O. Dorsey, "Ann. Rep. Bureau Ethnol.," 1881-82 [1884], p. 248).

ANIMAL BRETHREN.

Throughout southeastern Australia and probably elsewhere in that continent, there is a peculiar association of a species of animal, unusually a bird, with each sex. To take two examples given by Mr. A. W. Howitt (Journ. Anthrop. Inst., xv. 1886, p. 416), "the bird totems of the Kurnai are the Emu, Wren, and the Superb Warbler, which are respectively the 'man's brother' and 'woman's sister.' . . . When we turn to the Kulin, we find both the Kurnai totems in just the same position. In addition there are also a second male and female totem, namely, the Bat and the small Night Jar." Mr. Howitt is careful to point out, "they are not true totems in the sense that these represent subdivisions of the primary classes; yet they are true totems in so far that they are regarded as being the 'brothers' and 'sisters' of the human beings who bear their names." Mr. A. L. P. Cameron (*ibid.*, xiv. 1885, p. 350) also states that these are "something different from ordinary totems." Later Mr. Howitt (*ibid.*, xviii. 1888, pp. 57, 59) says: "Among the Wotjobaluk tribe which have a true tometic system these were real totems, although of a peculiar kind. They were called *yaur*, or 'flesh,' or *ngirabul*, or *mir*, just as were the totems proper. The only difference was that the Bat was the brother only of the men who bore it as their totem. . . . It is evident that the institution of the 'man's brother' and the 'woman's sister' as totems is very widespread throughout Australia. I have traced it over an extent of about a thousand miles and in tribes having marked differences in language and in social organization. It seems to be very persistent and enduring, for it remained among the Kurnai in full force after the ordinary social organization in class divisions and totems had become extinct." Mr. Howitt speaks of these as "abnormal totems," and Dr. Frazer ("Totemism," p. 51; "The Golden Bough," iii. p. 416) calls them "sex totems." As it appears most desirable to distinguish between this cult, which is confined to Australia, and true totemism, I propose in default of a distinctive native term, to call these reverenced animals "animal brethren." Although the natives do not appear to distinguish nominally between these animal brethren and ordinary totems, it does not follow they are to be considered as the same. I am calling attention to an analogous confusion of terms in the totemism of Torres Straits.

I must now pass on to a further consideration of true totemism as understood by Tylor, Frazer, Lang, Hartland, Jevons, Durkheim, and others, as it is impossible within the limits of an address to give an account of all the varieties of pseudo-totemism.

(To be continued.)

* But Mr. E. S. Hartland points out ("Folk-lore," xi. 1900, p. 61) that we have clear evidence from the legends of the descent at all events of some of the clans from non-human ancestors; and Mr. Hill-Tout says: "Among the Salish tribes it is uniformly believed that in the early days before the time of the tribal heroes or great transformers, the beings who then inhabited the world partook of the character of both men and animals, assuming the form of either apparently at will."

* E. Durkheim, L'Année Sociologique, v. 1902, p. 330; cf. also F. B. Jevons, "Introduction to the History of Religion," 1902, pp. 155, 158.

THE GREAT COST OF ALASKAN MAILS.

A GOVERNMENT report gives some interesting details of the Alaskan mail service and shows to what great expense our government is put in extending its postal system. The report announces that the postmaster has just despatched mail from Point Barrow to Kotzebue Station by reindeer. The report is dated February 10, showing that although all but 572 miles of the journey to this city was in United States domain, almost five months were consumed in the journey.

TRAVELED 6,904 MILES.

The total number of miles traveled was 6,904. From Point Barrow to Kotzebue is 650 miles, and this part of the journey is covered by means of reindeer. From Kotzebue to Nome is 400 miles, a stretch on which both reindeer and dogs are utilized. From Nome to Unalakik is 230 miles, where dogs furnish the motive power. From Unalakik to Tanana is 363 miles, and Tanana to Eagle is 567 miles, both of these stretches being covered by means of dogs. This makes a total of 2,210 miles traveled in Alaska alone. The next stage is 594 miles from Eagle to Skagway, via Dawson, a total of 594 miles, of which 572 is in Canada and 22 in Alaska, 460 miles of the distance being by horses and dogs and 112 by railroad. The 1,000 miles of distance between Skagway and Seattle is covered by steamer, and the 3,100 miles from Seattle to this city by railroad, of course. This completes the 6,904 miles.

Mr. Stone, who made these interesting calculations to-day, summarizes the various methods of transportation of mail between these points as follows:

By reindeer, 650 miles; by dogs, 1,630 miles; by horses, 412 miles; by steamer, 1,000 miles; by railroad, 3,812 miles. Total, 6,904.

ONE TRIP COST $2,329.

It is figured that the total cost of one mail trip, regardless of the weight carried, from Point Barrow to this city is $2,329. This is based on the fact that the round trip rate for carrying the mail from Point Barrow to Kotzebue, according to the contract, is $750, making the single trip $375, one-half the round trip rate, and the other stages of the trip are similarly computed. Thus the cost, whether there is one letter or a big bulk of mail, from Kotzebue to Nome is $250. Nome to Unalakik $263, Unalakik to Tanana $402, and Tanana to Eagle $529. The transit across Canada does not count, as that is paid by the British government, and the steamboat trip from Skagway to Seattle is $169. These figures for Alaska are absolute, and the remainder of the $2,329 is $341, which is approximate and adopted on the basis of 11 cents a mile as the average railroad rate for the United States.

THE PEARLS OF WESTERN EUROPE.

MANY are ignorant of the fact that Asia has not a monopoly in the producton of pearls, and that Europe has also its pearls—pearls French, Scotch, and Swedish. A letter from Stockholm says: "The fishing for pearls has commenced on our coast, at the place called Ljusne Elf, where they are often found of extraordinary size and beauty. Inspector Stümberg has discovered a magnificent one at Strömbocken. It was especially remarkable for its marvelous transparency. He has sent it to Norway to have it examined and appraised. As you probably know, the pearl fishing is much more successful at Ljungan and at Voxnan than at Ljusne Elf; it will become no doubt a rich and fertile field for our seacoast population."

In Scotland and Ireland are a multitude of poor people of both sexes and all ages, who always find the wherewithal for living from their search for pearls, while some draw prizes, as in the placers of gold or of diamonds. The fishing is rather difficult in the large streams. It is necessary to wait for the summer to lower as much as possible the level of the waters. If these are not deep, the fisherman, on discovering a bed, usually plunges in a rod split at its extremity and seizes the shells with these primitive tongs. Some prefer to dive, and some are able to creep along under water. The most fortunate are those who own a boat and make use of large tongs, similar to the oyster tongs of the Americans.

The streams originating in ponds or lakes furnish the best pearls. Only four of these are known; the Ugie, the Ythan, the Don, and the Isla. These are fields of the first rank, although very beautiful pearls have been found in the Doon, the Teith, the Forth, the Eara, the Tay, the Lyon, the Spey, and the Conan.

Similar results are possible in France. The pearl-bearing mulette, which yields pearls valued at 2,000 francs, is not at all peculiar to the British Isles; it flourishes in abundance in our streams. Without speaking of the Rhine, which is no longer our possession, it is common in the Loire, and in the greater portion of our gravelly rivers. We have also several similar pearl-producing species. We have the littoral, smaller and with a squarer shell than the preceding; the

mulette of the artists, whose shell, oblong and fine, contains certain dry colors employed in the arts.

Not only do the fresh-water mussels of our country often inclose pearls, but the salt-water mussels should not be overlooked. In the coves and lakes, which they like to frequent, many of our readers do not suspect that magnificent pendants for neck and ears lie concealed.—Translated from Le Diamant.

DETAILS OF CONSTRUCTION OF THE PARIS UNDERGROUND RAILWAY BENEATH THE PLACE DE L'OPERA.

THE citizens of Paris have been much interested of late in the work that has recently been started at the Place de l'Opera for the construction of the Metropolitan Railway. The work is yet only in an inceptive stage, and, up to the end of 1903, it will necessarily prove an obstruction to traffic of all kinds upon this busy square, which is situated in the heart of Paris. We shall, in a few words, make known the object of the work, its importance, the difficulties to be surmounted, and the peculiar arrangements that the constructing engineers, in accord with a special committee appointed by the Prefect of the Seine and composed of M. Bourard and several municipal counselors, have made for the reduction to a minimum of the momentary, but obligatory, obstruction to traffic.

As shown in Fig. 2, three metropolitan lines cross each other, one above another, in the very center of the square. The first, which is now in course of construction, is that which, starting from the Courcelles station upon the line of the northern external boulevards, comes in through Rue Auber and continues on toward Menilmontant through Rue du Quatre-Septembre.

The second, which passes beneath the first, is that which, starting from Palais-Royal, follows Avenue de l'Opera, and continues on toward Place du Danube through Rue Halevy and Rue Lafayette. Finally, the third, which passes beneath the two first, is that which, having its origin under the boulevards, near Rue Chauchat, extends toward Auteuil through Boulevards des Capucines and de la Madeleine.

Given the very loose soil that had to be traversed, and especially the aggravating circumstance that a stratum of water is met with at a maximum depth of 33 feet, it is easy to see how difficult it is to effect the crossing, one above another, of three tunnels, which themselves, through their superposition, occupy a height greater than the 33 feet between the level of the roadway and the stratum of subterranean water. It was this same water that, at the time of the construction of the Opera, rendered the laying of the foundations of a part of this building so difficult. The only practical means, and that which the city engineers indorsed, was to effect the crossing of the different lines in an immense pillar of masonry placed in the very center of the square, as shown at *A*, Fig. 2, and in perspective in Fig. 1. This pillar will have to be established upon a metal caisson, which will be sunk by compressed air down to hard-pan, which, according to soundings, is found at a depth of 72 feet below the roadbed. The apertures *A* and *B* are those through which will enter the Courcelles-Menilmontant line, which occupies the upper part of the pillar. Just beneath, and through the apertures *D*, *C*, will pass the

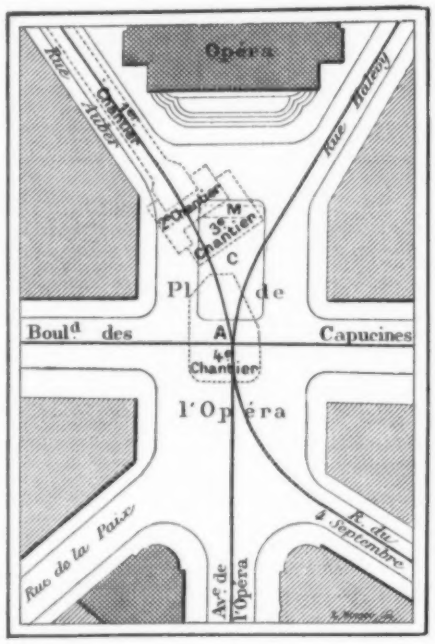


FIG. 2.—GENERAL PLAN OF THE WORK.

Palais-Royal-Place du Danube line, and, finally, at the lower part of the pillar, at about 65 feet beneath the roadbed, will cross, through the apertures *F*, *E*, the Auteuil-Opera line. These various superposed lines will be supported by metal floors, and a final floor, likewise metallic, above the Courcelles-Menilmontant line, will separate the latter from the roadway of the boulevard.

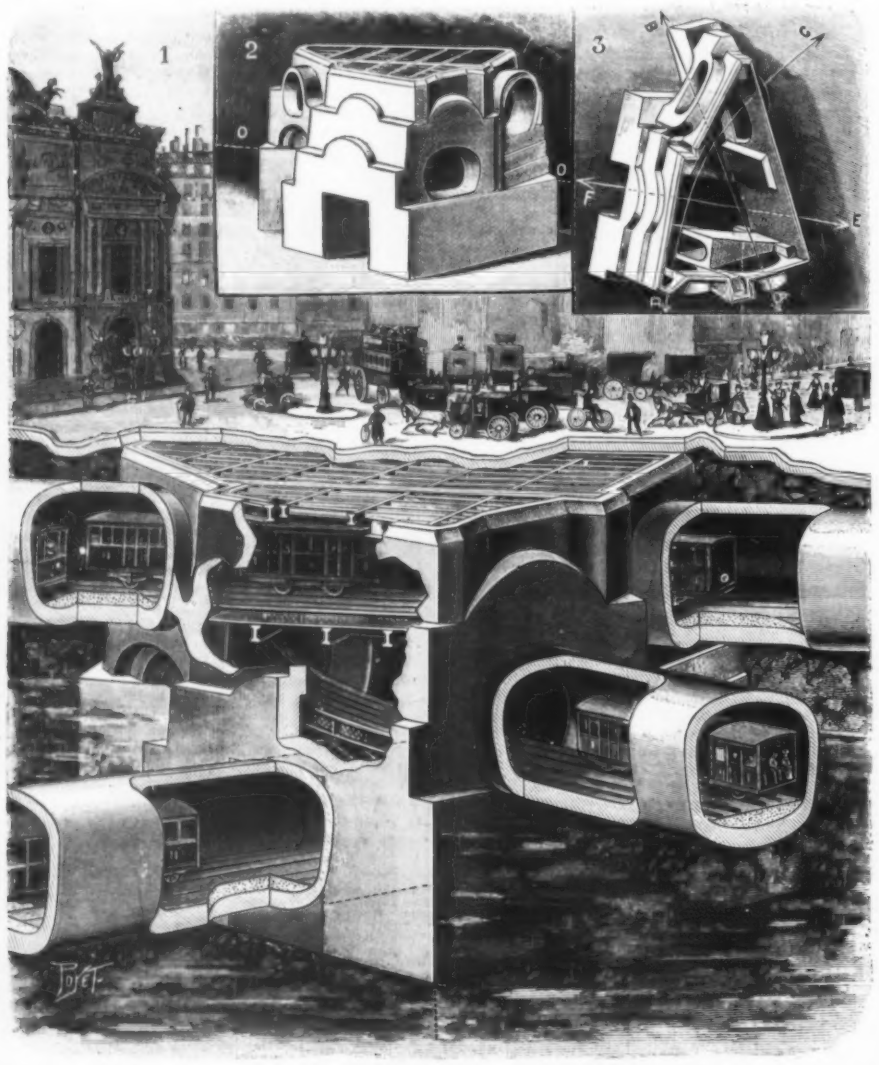


FIG. 1.—1. GENERAL VIEW OF THE PIER SERVING FOR THE CROSSING OF THE METROPOLITAN LINES. 2. MODEL OF SAME. 3. SECTION OF THE MODEL.

The above description will give an idea of this new engineering work. It is easy to understand its absolute necessity and importance, and to see that a year's time will be scarcely sufficient in which to finish it.

Let us now see the measures taken for the reduction to a minimum of the obstruction to traffic that the work will cause. For this purpose, let us refer to Fig. 2, in which is indicated the situation of the working points during the different phases of the work up to its entire completion. Working point *I*, bounded by dotted lines, is the present one. It is located upon the site occupied by the tunnel of the Courcelles-Menilmontant line, the work on which is being actively pursued. When the work at this point is finished, which will be in a few days, the palings will be transferred successively to points 2 and 3, the latter being the one that will serve for the establishment of the station. The dotted lines of Fig. 2 indicate the successive positions of the palings that will inclose the working points as they are shifted. It will be seen that until the completion of the station work, Place de l'Opera will remain free for general traffic. Traffic on Rue Auber will alone be prevented, and yet but partially so, since it will be possible for pedestrians to walk upon the Opera side of the roadway. After the work is finished and the palings have been removed, work will be started at the last point, No. 4. This will be the most important one, since it is here that will be sunk the masonry pillar in which the three metropolitan lines will cross each other. This point, indicated by dotted lines in Fig. 2, occupies the very center of the square at the intersection of Avenue de l'Opera and Boulevard des Capucines. It will therefore intercept the direct traffic of one boulevard, or the traffic between one street and the other; but, nevertheless, it will be easy to pass around the palings, and the more so in that then the three first working points will have disappeared, Rue Auber will have become free, and vehicles and pedestrians will find plenty of room on the Opera side.

As for the present refuge, represented at *C* in Fig. 2, that will have disappeared for a time, but will be replaced by another and provisional one of smaller size, represented at *M*, upon the plan, by interrupted dashes.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

COLORS FOR SOAPS AND PERFUMES.

IT is essential that various perfumes prepared for the toilet should not only be very odoriferous—this being of course their principal characteristic—but that they should also be "taking" to the eye, which effect can only be produced by means of coloring matters. The color to be used is governed by the nature of the object, and should be in keeping with the use to which the perfume is to be placed. Thus, for example, a *rose* dentifrice lotion should possess a beautiful flesh color; lettuce soap a light green, and so on. To a certain extent, says M. Piesse in Chimie des Parfums, it is best to leave the selection of a coloring matter to the judgment of the laboratory principal; and as long as the color adopted is in accord with the nature of the article no objection should be raised, provided it be inoffensive and not injurious to the skin.

Colors of numerous hues can now be obtained by chemistry. That there are also a number of mineral colors there can be no doubt, but most of them are poisonous, and may not therefore be used in the manufacture of preparations for the toilet.

The following will show the different colors that can be employed for various substances:

Green Colors.—Alcohol can be colored green by steeping some dried leaves of almost any kind of plant in it. Spinach or sage leaves—as likewise several others—dried either in the sun or artificially by means of a current of warm air, and then placed in spirit of wine, would give to the spirit several pretty green shades. Violet and cassia pomades also color the spirit green by steeping, but it is a general rule that the prettier the shade, the older the pomade or dye. Violet or cassia extract, when fresh, is of a dull green color, but if kept for some time it will assume a hue more agreeable to the eye.

Aniline greens, usually known by the name of malachite green, crystal green, and bright green, are employed in the same way as red.

Those perfumery articles which have been colored green have met with a large measure of success, which will explain the using of a little cassia in bouquets, cassia being of a pretty color.

A green color can be given to oils and pomades in the following manner:

Place some spinach or walnut tree leaves in the body in which the green coloring matter of the plants (called chlorophy) is dissolved. When all the color has been obtained from the leaves, the fatty bodies are racked and fresh leaves are supplied. The same operation being repeated several times with the same fatty body, it holds the coloring matter in solution, becoming of a beautiful dark green color.

Salts of copper should not be used, however, both Scheele and Scheveinfurt greens being more particularly guarded against owing to their being strong poisons.

Soap can be colored green by making a mixture of paste in a deep pan containing from 6½ pounds to 15 pounds of fresh palm oil for 220 pounds of soap. This amalgam gives a good yellow soap, to which, say, 2 to 3 ounces of malt, sky-blue, or ultramarine blue, dissolved in 5½ gallons of water, is added. The blue color and the yellow soap, if well mixed together, will give a vegetable-green tint. Green soaps are sometimes made with chromate of potash and chromate of lead. It should be mentioned, however, that all these substances are very dangerous.

Powders can be colored green by employing fresh herbs, such as parsley, spinach, walnut and other leaves, ground and mixed with starch.

Both sky, Prussian, and indigo blues can be used without danger.

Yellow Colors.—Saffron, palm oil, and turmeric are the substances which are mostly used by perfumers for dyeing yellow.

Spirit can be made to receive a yellow color, or, rather, a beautiful uranium tint, by steeping some jonquil pomade in it; the pollen of the flowers at once communicates its color to the body, which in turn passes it to the spirit of wine. Spirit can also be colored yellow by steeping some roots of turmeric in it (the *Curcuma longa* of India)—the well-known ingredient used in the preparation of curry powders, etc.

The coloring principle of turmeric lies in its root; it

is soluble in spirit and petroleum ether, and can be obtained by draining the roots either through spirit or petroleum ether, the solvent being then distilled. A fluid residue will thus be obtained which can be easily mixed up with the fatty matter.

This color should not, however, be used in alkaline preparations, as the basic bodies turn the turmeric brown. Emulsions and such like preparations can be colored yellow by using saffron. It may not be generally known that Saffron Wolden (Essex) received its name from the very large extent to which saffron used to be grown there. The color is extracted the same as for turmeric.

The best substances for coloring pomades yellow are jonquil, rose, or palm oil pomades; the latter variety is cheaper, though the two first descriptions provide a more agreeable odor. The shade of yellow of the rose pomade is considerably darker than that of the jonquil, but it is not so powerful as the palm oil. It owes its color to the pollen of the roses from which it is made, in the same manner as for the jonquil pomade, that is to say, by steeping.

Palm oil is not actually an oil in France; it is an opaque substance, more consistent than butter, which cannot consequently be used to color true oil yellow.

RED AND BROWN COLORS.

Carmine.—To obtain carmine, finely-ground cochineal is treated with ammonia, to which a little weak alum solution is added. It is then exposed to the air, and in a little while beautiful red flakes will form, which are gathered and dried.

Carthamum Red.—The flowers of the *Cartamus tinctorino* contain two coloring principles, red and yellow. The *modus operandi* for extracting the coloring matter is as follows:

The flowers are first dried and then treated in water, to which they impart their yellow principle. The residue is treated with a soda solution, in which the red coloring matter dissolves. It is precipitated from the solution by means of a judicious addition of acetic acid, the insoluble matter being then collected and dried.

Saffranine can be used as a substitute for carthamum with advantage.

Alkana Red.—The beautiful red coloring matter contained in the root of this plant can be extracted by means of petroleum ether, and also by melted hog's lard or warm oil. A purple or rose-colored product is obtained, according to the concentration, which will mix well with the fatty bodies. This coloring matter is very fast.

Vermilion.—Vermilion is a toxic substance which can be used to color soaps without danger, as it is insoluble.

Rose soap is a white fat colored by powdered vermilion in water or a little spirit, which should be well mixed in when the paste has melted, though not when it is too warm.

Brown-red.—Ratany root gives the best color to spirit. Botanists recognize the plant by the name of *Krameria triandra;* it grows principally in Peru. There is, however, another species possessing almost identical properties, coming from the Caribbean Islands, namely, the *Krameria xina.* Both varieties are nothing more than shrubs, and are only grown on account of the root, which, as mentioned above, imparts a beautiful color to the spirit, and is likewise very odoriferous. This root is also largely used in the preparation of pomades and tooth lotions.

A good red-brown color can also be obtained with a dye of red sandalwood. This is the wood of the *Pterocarpus santalinus,* a tree growing on the mountains of the Coromandel coast and largely imported for the use of dyers, along with another variety, the *Pterocarpus flavus,* the yellow sandalwood which colors spirit yellow. Cedar wood also gives it a beautiful red color, it being extensively employed by French perfumers for the coloring of liquid dentifrices.

Brown.—Brown sugar or treacle, baked in an iron vessel almost to the point of burning and then dissolved in lime water, constitutes what is known by dyers as "brown dye" and by confectioners as "caramel." For the latter preparation, however, pure, and not lime water is used. This dye is also employed for giving the desired shades or tints to soaps and hair washes, but as it remains insoluble either in fatty bodies or spirit of wine, it does not color them.

Violet and Mauve Colors.—All these hues can be obtained by mixing reds with blues in suitable proportions and therefore either colors of vegetable or animal origin or aniline colors can be used.

The spirit can be given all the hues the perfumer may desire with aniline colors; the slightest difference in the shade of a color is sufficient to justify a special name being given to it. The two shades of color which are in best repute are those generally termed "fuchsine" or "magenta" and "solferino."

Oils, fats, wax, and spermaceti can be easily dyed red with the root of the *Anchusia tinctoria* usually called "alkanet." A good amount of this root is used by the perfumery industry.

To color oils, a pound or two of these roots (ground) are placed in a vessel, which is put into cold water. The root is then covered either with olive or almond oil, the vessel being kept warm for several days, when the oil is drained off and bottled, the name of "red dye" being given to it. If the shade is not as dark as required at the first attempt, the same oil is poured over fresh leaves, two, three or even more times, until the desired hue is obtained.

This red dye can also be used for giving to oils and pomades the various tints, from rose-red to crimson.

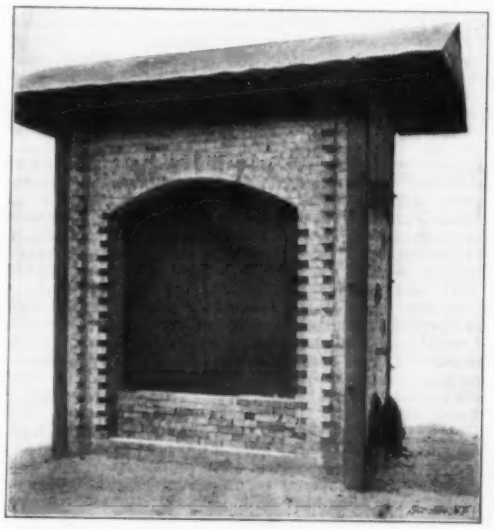
It is interesting to note that, so extensively is this dye used in England, that, according to M. Piesse, about 7 tons of alkanet roots are imported into this country annually.

Oils and other fatty bodies can also be colored different shades by mixing them with an alcoholic solution of solferino—green, blue, mauve, etc. When the oils, etc., have become colored, the alcohol is evaporated either by heat or precipitation. By this means fatty bodies can, for the first time, be given the most numerous tints—from violet to the most delicate rose color.

It is even simpler and more economical to substitute a small amount of glycerine for the alcohol, or spirit, afterward using the solution to color the fatty bodies, oils, or pomades.

Blue Colors.—Aniline and ultramarine blues and indigo carmine are used in perfumery. The indigo carmine is prepared by sprinkling smoking sulphuric acid over finely-ground indigo. In twenty-four hours' time some carbonate of lime (chalk) is added to it until effervescence ceases. It only remains now to filter it. Indigo carmine must not, however, be used in soaps, as it would color the skin blue.

Black Color.—There is no true black which is soluble either in water or spirit, though India ink remains in suspension longer than any other substance.



GAS OVEN FOR TESTING FIREPROOF PROTECTION SUCH AS DOORS, SHUTTERS AND PARTITIONS IN BUILDINGS.

Fats and soaps can only be colored black at a little expense with smoke black first ground in oil and then added to the fats or soaps in sufficient quantity to give the desired shade. Wood charcoal is often used as a substitute for smoke-black.

Some kinds of soaps can be colored sufficiently by the different essences employed to give them their fragrance, such as, for example, spermaceti or lemon soap, which becomes of a beautiful pale green color by the simple mixture of the essence with the fats.

For the coloring of transparent soaps, an alcoholic extract of cochineal or of aniline colors (fuchsine, saffranine) is employed for the red color and picric acid or turmeric for yellow, etc.

The aniline colors are used dissolved in glycerine. The color disappears upon cooling of the soap, but reappears at the end of a few days. In time, however, it vanishes entirely.—Chimie des Parfums.

THE UNDERWRITERS' LABORATORIES.*

By DAY ALLEN WILLEY.

THE great diversity of appliances which have been invented and patented to be utilized in some connection with heat has led to the equipment of a building in Chicago, constructed and equipped with apparatus solely to test the practical utility of such inventions. It is called the "Underwriters' Laboratories," and, as its title indicates, was planned and is maintained by a number of insurance companies doing business throughout the country. In fact, no less than 135 of these corporations, located not only in the United States but in Canada and Great Britain, contribute to its support and maintain a staff of electricians, engineers, and chemists, who have a wide reputation as experts, to conduct the elaborate experiments which are carried out.

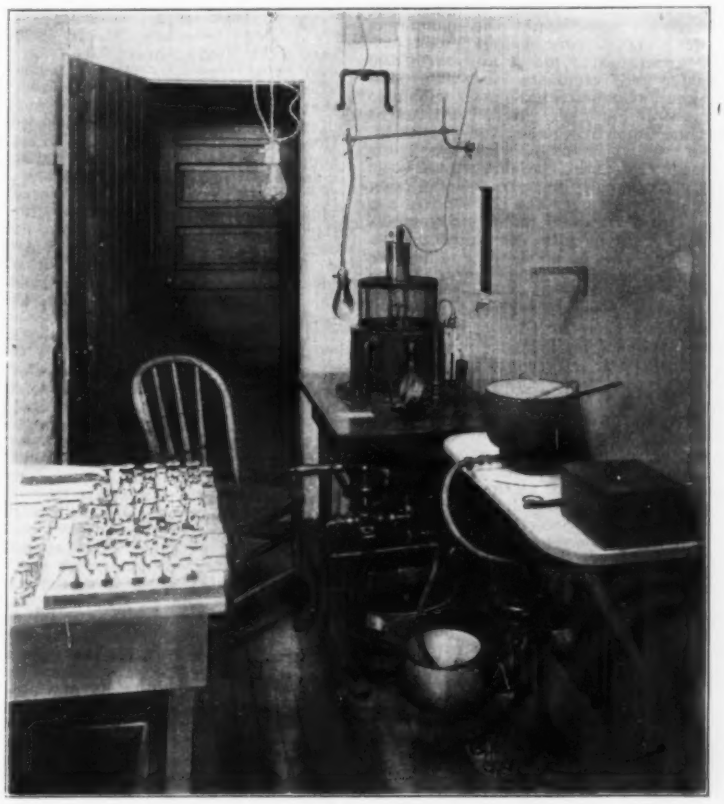
The scope of the institution is very broad, as may be appreciated from the fact that it contains apparatus for exhaustively testing every kind of fire nozzle, alarm systems, sprinkling apparatus, fireproof brick construction, fire doors, insulation, electrical installation, gasoline and vapor gas lighting, machines, and lamps, gasoline engines, acetylene gas machines, chemical fire extinguishers, fire shutters, wired glass, hose, hydrants, water pipe valves, and all their branches. Going a little further into the scope of this work, it may be sufficient to point out that in one of the departments alone—electricity as it relates to fire protection—there are no less than 177 separate and distinct divisions.

In fact, the apparatus is of such a character as to give the investigators an intelligent idea of the actual value of the invention in connection with the purpose for which it is intended. For instance, any manufacturer or inventor who is about to put on the market a device that he believes may be of value in preventing or retarding fire in a building may have it tested here under every condition of temperature, water or atmospheric pressure, or durability. Fifty per cent of the cost of such investigation must be paid by himself, the balance being provided by the insurance companies. If his device is found to be in any way defective he is furnished with a written report telling him exactly in what respect it is weak. If, on the other hand, it comes up to the rigid standard required, it is listed in the offices of all the stock fire insurance companies in the country, with other apparatus of the same character that has passed the test. The same general plan is followed in deducing the practical value of the appliances considered, but a decision as to merit is only rendered after several experts have considered it and results of the tests have been carefully verified.

The electrical installation is one of the most notable features of the laboratories. It is so frequently required to test insulated material, lamps, motors, and other designs, that the machinery in the section of the building devoted to this work can transmit a current of 40,000 volts if desired. The maximum current is employed in the application of the "break-down testing set," as it is termed, used in testing the value of switchboard material and wiring of all kinds. The mechanism is so arranged that a record can be kept of the greatest voltage which each article will withstand before being used by the service.

The methods for automatically extinguishing fires by means of sprinkler and other systems are naturally of much interest to the underwriters, who endeavor to obtain data as to the most valuable ones by experiments made here. Nearly all of the systems are made serviceable by one method—the fusing of metal stays when temperature near them reaches a certain point, and the resulting release of sprays of water. So many different features enter into this method of fire retarding, and so much depends on its successful action not only with regard to its effect on the fire itself but also on the reduction in the rate of insurance where it is installed, that the greatest care is necessary in testing. Some types of sprinklers will operate too soon;

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



DEPARTMENT FOR TESTING FIRE-SPRINKLING APPARATUS AT VARIOUS TEMPERATURES. IN THE CYLINDER MOUNTED ON THE TABLE, THE TEMPERATURE IS ESTIMATED BY THE APPARATUS CONNECTED WITH THE CYLINDER.

others will not release themselves soon enough; still others when released will not send out a sufficient flow of water, and others will give out so much that it will not only drown the fire, but cause heavy insurance losses by water damage to goods in rooms below. The sprinklers are therefore tested under every conceivable condition, and apparatus for this work is so constructed that the exact area of water distribution made by a sprinkler head can be figured in inches. A standpipe over 60 feet high and 6 inches in diameter is attached to the building for pressure making purposes wherever water tests are needed, and in addition there is in the basement a reservoir containing 5,000 gallons, with a 50 horse power pump for the trying valves of all kinds, standpipes, nozzles, and fire hose. All of these are subjected to the most arduous service conditions with the result that many break under the strain. When that happens, the men engaged in testing have recourse to safety stops placed in all the pipes leading from the reservoir, to save themselves from drowning in the great rush of water that sweeps in a flood all about them.

Natural gas is utilized in great quantities wherever it is necessary to duplicate actual fire conditions. One feature of this work is the subjection of bales of cotton to all kinds of flame surfaces in order to ascertain what methods of baling can best protect the cotton from destruction by fire or from damage by water. Cotton growers are continually experimenting with new methods of pressing and baling, and the laboratory experts receive all sample bales prepared by these processes and make exhaustive tests with both fire and water. The testing of fire-retarding paints and other treatments of a similar character for woodwork of every description is another important part of the work of this establishment. The sections of boards so treated are hoisted as if they formed parts of walls or ceilings, then are subjected first to mild heat, then to great heat, then to the flames, and afterward to charred fragments of wood and dry-goods material. The results in each case are carefully noted.

To determine the efficiency of fire doors and partitions, an oven has been constructed, one side of which contains an archway of firebrick into which the door or partition is closely fitted, the idea being to place it in the same position it would occupy if forming a part of the fire wall in the interior or on the exterior of a building. In the apartment formed by setting the door in the wall are placed piles of silk, cotton, and woolen fabrics, which represent the "stock" to be protected. The oven, which is separated from the apartment, contains a series of gas pipes so arranged that when the gas is turned on and ignited the flames sweep against the door as if issuing from the floor and sides of the oven. Thermometers in water tubes are arranged to record the temperature, so that the heat-resisting power of the barrier can be determined by regulating the flow of the ignited gas. As an indication of the efficacy of such protection, after exposing the door to a very hot flame of considerable duration, it was found to be twisted and bulged, but it held the flames in check and left a very satisfactory temperature in the apartment where the dry goods were stored. When the furnace cooled down the door was taken out, tapped and cut into, and examined for flaws and cracks. The result being very satisfactory, the inventor was so notified, a copy of the report of the experiment was sent to him, and a duplicate to all the insurance companies.

Naturally a percentage of the requests made for tests bring to the institution dangerous and worthless apparatus. Recently a man went to the laboratories with a home-made acetylene-gas generator "for use in private residences." He would not listen to the protests of the chief engineer of the establishment, but insisted that his machine was perfectly safe and defied the experts to prove that it was not. He was taken into the room where all experiments of a dangerous character are conducted. A very moderate test sufficed to blow the apparatus to pieces and cover the inventor with plaster and fragments. He was taken out into the yard and put under a hose, after which he went away convinced of his error. It is contrivances of this kind that are eagerly watched for by the institution, and every effort is made, when once they are found, to prevent their sale. In this way a large amount of property is annually kept from destruction by fire, and communities all over the the country are spared the loss of life that would undoubtedly result from the flooding of markets with the dangerous devices which would otherwise be marketed and sold as "perfectly safe and harmless." Much material concerning the cause of fires is collected every week by the laboratories' officials from field agents, which is tabulated and made the basis of careful study with reference to future tests of apparatus. Whenever a fire can be traced directly to defects and insulation of electric wires or any other cause connected with the fittings that go into buildings, the character of the apparatus and the name of its manufacturers is obtained, this information also being filed away for reference. The causes of several very disastrous fires in New York and other cities have been discovered through investigations by the staff at the laboratories. In one instance a hotel in the metropolis was destroyed by flames originating from a defective electric light "switch" which the hotel "electrician" had made by soldering together parts of a suspender buckle. In another instance sulphur fumes from the funnels of locomotives standing in a roundhouse so damaged the insulation of an electric-light wire as to cause its current to communicate with the building. Gas pipes accidentally brought in contact with wiring carrying a heavy current are frequently actually burned through and the gas ignited, to the danger of surrounding property.

The principal officers of the company are H. C. Eddy, chairman; W. H. Merrill, Jun., secretary; B. F. Hardy, assistant secretary, and W. C. Robinson, Benjamin H. Glover, Fitzhugh Taylor, Dean Harvey, and Morris Moskovitz, engineers.

Cement for Glass Labels.—

Rosin	1 part
Yellow wax	2 parts

Melt together.—Drug. Circ.

A SEARCH FOR THE TIBER'S TREASURES.

PROF. CIRO NISPI-LANDI, the author of the latest scheme for exploring the bed of the river Tiber, is no mere "dreamer." A man of profound learning, he now holds the responsible position of inspector of the national monuments to the Italian government, and is the author of several thoughtful works on ancient Rome. It was the professor's historical studies and researches that inspired him with his great idea of searching the Tiber for treasures. They directed his attention first to the length of time during which Romans, rich and poor alike, cast into the slow-flowing river their most cherished possessions, and also to the period, unexampled in history, of thirty-four centuries in which the Tiber was the center of momentous events. Prof. Nispi-Landi's notions were strengthened by what he saw while in charge, several years ago, of the work of building the Tiber's embankment. The professor noticed, as he tells me, that "whenever and wherever the Tiber was searched in the course of bridge-building or of the work on the embankment, ancient and valuable things always came to light." Generally they were valuable enough to pay the entire cost of the operations. For instance, one Italian bridge-building firm, in laying the two pillars of the Ponte Palatino, discovered antiquities to the value of several million lire. In adjusting the foundation-pillar of the Ponte Garibaldi three beautiful antique bronze statues, one of Bacchus and one of Venus, came to light, and in widening the Ponte Cestio, antique jewelry, one piece of which was a wonderful gold collar of turquoise, and other valuable relics were drawn up from the depths where they had lain for years. In the course of the complete work on the embankment enough ancient works of art and other relics were discovered to stock one of the richest museums in Rome, that of the Baths of Diocletian.

"Most of the treasures," remarked the professor, in response to one of my questions, "are certainly to be found in the most central part of the river, and have remained undiscovered for that very reason." He consented to give a hint of his plans. He has, for this purpose, divided the Tiber into "zones," or districts. They are eleven in number, No. 1 covering most of the Tiber in Rome proper, the others the course of the river outside the Eternal City. "We shall proceed," said the professor, "by digging parallel trenches for the first zone, where the ancient source of the river is dried up, with the aid of steam-pumps; and where the Tiberine waters follow their natural course, with pneumatic tanks modified and adapted to the special use of river exploration." The enterprise will be financed by Chevalier William Millar, a wealthy Anglo-Italian of Leghorn, who has implicit confidence in the savant's scheme. Just when the actual work will be begun is not yet decided. The permission of the state was given to the enterprise some time ago, but recently some "recommendations" have been made by the museum of antiquities. Compliance with them has delayed matters, and it may be some time before the delving begins in earnest.

Search in the Tiber always has been richly rewarded. The professor goes back as far as the thirteenth century, quoting one of its historians, Falminio Vacca, who described how, a small boat having sunk near the Ponte Sublicio and several swimmers being engaged to fish it out, arrows, swords, breastplates, arms of every description, "and other beautiful objects" recognized as purely Etruscan, were discovered and brought to the surface. But, after all, it is necessary only to review one's Roman history a little to convince any one that there should be riches in the Tiber. That they were put in is certain, and Prof. Nispi-Landi states that in all his research he has been unable to find any record of any large quantities of them having been taken out. The records of sacrifices to the Tibertine deity go back to the beginnings of Roman history. Even Virgil tells how Æneas promised Father Tiber that if he would protect him from peril, "Thou shalt ever be worshiped by me with homage and with gifts." The example of Æneas was followed by the generations that came after him. Sacrifices were made on the eve of great events, such as battles, during times of national peril, to make sure of having the god on the suppliant's side, during great rejoicings, and to commemorate illustrious men who had died. These were the great public sacrifices, of course, but private individuals in prosperity and grief offered personally similar sacrifices, generally the most precious things they owned. Back in the time of the Arcadians, men used to be hurled into the Tiber, but soon they were replaced by puppets and graven images, and after this the offerings of money, jewelry, and precious things began.

It was not only the Romans who sacrificed to Father Tiber. The superstitious of all the southern races seem to have been pretty much alike at this time, and whatever force was near the river made votive offerings to it. The Huns, the Goths, and the Vandals all hurled a large part of the plunder derived from their sacks of Rome into the ancient stream. "Such offerings were," says Prof. Nispi-Landi, "the cause which contributed chiefly and for the longest period to enrich the bed of the Tiber with precious relics." Another cause, however, was the casting into the stream by the Romans of their possessions in order to prevent their being captured by enemies. For instance, after the defeat of Maxentius Saxa by Constantine, say the records, "Not only a great number of dead and wounded men and an immense quantity of arms and valuable objects, but even the treasures of Maxentius and the military chest of his army were thrown into the river to prevent their falling into the hands of the victorious foe." To save them from the Huns, and, later on, from the French, marbles, bronzes, statues, busts, and costly images enriched the Tiber. Add to all this treasure the hundreds of rich pagan statues and temple ornaments thrown into the river by the Christians, and the property of all who conspired to bring about the assassination of Cæsar, which had a similar fate, and an idea will begin to form of the vast treasures on the Tiber's bottom.

This Italian scholar, whose works, "Rome before Humanity" and "M. Agrippa and his Temple," are, by the way, well known in Italy, has not by any means contented himself with the conviction that treasures in the aggregate are below Tiber waters. He has drawn up for himself a list of individual relics of which history speaks, and has attempted to locate each in one of his "zones," according to the details which he has been able to gather as to its sacrifice. For instance, the professor believes that the sacred candlestick of Moses, the object that he would like best of all to recover, will be found in its first zone, or in that part of the Tiber near the famous Castel Angelo, close to the Vatican and St. Peter's, probably that part of the river that most Americans have seen.

Says the professor: "It is certain that religious objects were left untouched by the superstitious Alaric and Genseric; indeed, in 509 and 529 the candlestick was still to be seen in Rome. I regard it as certain that the emblem ordered on Mount Sinai, which stood in the Tabernacle of King David, which was carried round the walls of Jericho and was venerated by Cæsar and Pompey, was eventually lowered by the Jews down from the bow of Esculapius's ship on Tibertine Island in our first zone. The Jews themselves always have asserted that it is there. Consider that more than 1,900 years have passed since then, and that the candlestick was then about 1,550 years old, making a total of 3,448 years! What importance would its discovery have? Who should have the greatest claim to its possession? How much should be paid to the discoverers? It is not easy to answer these questions. Everything should be as wonderful as the candlestick itself."

Prof. Nispi-Landi will be one of the most disappointed men in the world if he does not bring up from the Tiber's bed thousands of suits of rich armor, of swords and shields, the property of the wounded men who through custom were hurled into the river and those that fell in the fearful battles on the bridges. Among these he expects will be the armor of brave old Horatius Cocles and his men, who kept the Pons Sublicius against the Etruscan army and finally leaped into the Tiber. "There must be," he writes, "in that part of the river arms, coins, ornaments, jewels, such as buckles, collars, and rings, all rare and valuable as the only relics of the Romans and Etruscans of those days." He expects to find the famous Minerva statue of Phidias, as well as those of Hercules, Mars, and Venus, with the pearl of Cleopatra. He believes he will bring to light the solid gold statue of Claudius II., which once stood in the Capitol and which was thrown into the Tiber to save it from the Goths.

Probably one of the first questions that will come into the mind of any one who reads this story of Prof. Nispi-Landi's great project will be: If the Tiber is so rich in treasures, why has no one tried to get them before, or at least why has no one thought of doing so? Well, for hundreds of years men of an ingenious turn of mind have been pondering upon doing and attempting to do that precise thing. For his scheme of searching the Tiber's bed, Prof. Nispi-Landi claims no originality; he claims only to be the first man who has yet set doing it with the proper mechanical devices. The list of those who in modern times have attempted to make the Tiber disgorge is headed by the name of the learned Cardinal de Polignac, who planned to deviate the Tiber from its course for about two miles, and then to dig for the antiquities which he believed were discoverable. Pope Benedict XIV. smiled on the Cardinal's project, but while the necessary capital was being gathered, the Pope died, and his successor was dissuaded from aiding De Polignac, on the ground that the climate of Rome might be injured.

In 1773, Don Alfonzo Bruzzi undertook the exploration of the Tiber by means of a cofferdam of his own invention. The device did not come up to expectation, for the water rose and overturned it. Yet, for the short time it worked, enough was found to pay all costs and leave a profit. The scheme of Joseph Naro, in 1815, was not so successful. He, too, believed the Tiber to contain treasure, but he tried to get it by means of a kind of mud-scraper, a "grattina," as he called it, which, whenever an incumbrance was met, was planned to strap it and draw it up. Only fragments of statues, marble blocks and funeral columns were, however, brought up by the "grattina." Garibaldi dreamed of searching the Tiber, but he, too, wished to deviate the course of the river, and this the Italian parliament refused to allow. The most recent man of celebrity to consider exploring the Tiber was the late Prince Alexander Torlonia. He, however, wanted to keep so much of what he found that the government refused to grant him permission to make a trial. The prince had felt so certain of success that he offered to deposit as a guaranty for the work the sum of a million and a half of lire, $300,000.

Prof. Nispi-Landi believes that he at last will succeed. He says: "I have now fulfilled all the formalities required by the minister of public works, and the ministerial decree will enable us, with new means and a positive and practical prospectus, to see the great river searched at last, and the abundant riches of intrinsic and artistic value of every ancient epoch triumphantly recovered. Let only fortune smile on our enterprise and merit and riches are ours!"—London Correspondent of the Springfield Republican.

PRESERVING THE RUINS OF ZIMBABWE.

EXTENSIVE precautionary measures are being adopted by the Chartered Company of South Africa to preserve the ancient ruins at Zimbabwe—the remaining relics of a by-gone age, the inhabitants of which were concerned in the exploitation of the gold mines. In the interior of Rhodesia, the Elliptical Temple, at the time of its discovery (already fully described in the columns of the SCIENTIFIC AMERICAN), there was an almost impenetrable jungle of African trees, creepers, and other plants, ranging to 10 feet in height, while the atmosphere was dank and fetid from the decay of vegetable matter. This undergrowth has been completely removed, but it was a difficult task, occupying fifteen men nine days to cut down the trees and plants alone. Another three days were devoted to the grubbing up of the stumps of trees and the removal of shrub roots, while the surface of the ground was also cleared of hundreds of years' accumulation of rubbish. Now one can stand within the temples and obtain an uninterrupted view of the surrounding walls. Several stones

of the conical tower on the north side have been overthrown by the action of the boughs of the trees springing from the walls, during high winds. The walls are thickly entwined with shrubs, the roots of which have secured a firm hold in the crevices between the stones, and the growing roots have dislocated much of the masonry. These shrubs have been cut back and removed as much as is possible without endangering the stability of the fabric. The tower, the most important portion of the ruins (since by its assistance archæologists will be enabled to locate the exact age in which the structure was raised) is in serious danger of falling, but every precaution is being made to prevent such a calamity. The passages and corridors have been cleared of growths and rubbish, so that the floors are now visible; the fallen stones from the walls gathered into piles where they have been dislodged, and a clearing 8 feet in width has been carried out right round the walls outside, so that it is now possible to examine the nature of the masonry of which the walls are composed.

DEATH VALLEY.*

By Prof. OSCAR C. S. CARTER.

JUDGING from the many highly sensational stories and frequent references to Death Valley, there is evidently a popular interest in that dreaded locality, which is in part explicable by the name it bears. The stories published are, as a rule, of little value, and give no idea of the climate, topography, fauna, and flora of a more absolute and arid desert than the Sahara. Our great deserts of the southwest have been but little written about by geographers and travelers, and it is only recently that accurate official reports upon them have been made. Capt. Clarence E. Dutton, in his report on the Grand Cañon, gave a description of the deserts of northern Arizona. Captain Gaillard, of the Mexican Boundary Commission, has given us, in a popular magazine, probably the best article that has as yet been written on an American desert. He was well qualified to write, because he traversed the entire region from the Rio Grande to the Pacific, erecting monuments to mark the boundary between Mexico and the United States. Mr. W. J. McGee, Chief of the Bureau of American Ethnology, who recently made the journey through Southern Arizona and Mexico, to study the Seri Indians, who live on the Isle of Tiburon, in the Gulf of California, has given us a fine description of the desert in his report and in separate articles in the Journal of Geography. A valuable article on the American Desert, by Robert T. Hill, has just appeared.

The above descriptions stand out like oases in a barren desert. These deserts of the Southwest, which take in the southern parts of California and Arizona, are called the Colorado Desert, from the river of that name which empties into the Gulf of California. They are hotter, drier, and more arid than the Sahara, as proved by the official records of the Boundary Commission. The early days of '49 saw much suffering and hardship endured by the overland travelers across the desert to California, and one of the most pathetic stories of suffering ever told was narrated by the survivors of a Death Valley party. They followed the old Santa Fé trail through New Mexico and Arizona, the same that the Santa Fé Railroad now parallels. Those who traveled north from Mexico across the Colorado Desert to California shared even a worse fate, as their bleaching bones along the desert testify. In September, 1849, a party of 500 emigrants left Utah for the land of gold. Their household goods were carried in the typical prairie schooners drawn by oxen. They left full of hope and good cheer, but in time a dispute arose as to the route and the party divided; some went east to strike the trails between Santa Fé and the Pacific, but the main party forged ahead to cross the land of the mirage and thirst. When they reached the plateau country, the land of the mesa and cañon, their canvas-covered wagons were useless. The green of the upland and meadow, so familiar in their eastern home, was wanting here; instead long lines of plateau and mesas with steep precipitous slopes met their view at every turn. These glaring red table lands could not be crossed unless they knew the country, so they packed their belongings on the backs of the sturdy oxen and trudged wearily along across the burning arid wastes. One by one the oxen perished and starvation stared them in the face; some of the more vigorous pushed ahead and reached Death Valley, where they perished miserably. It is said that one poor fellow, left for dead, recovered sufficiently to crawl on his hands and knees more than two miles after his companions and then perished. The remnant of the expedition crossed the valley at a narrow part and lived for days on a jelly made from boiled ox-hide. Gaunt and emaciated they slowly climbed the mountains and the survivors were nursed back to health on a ranch in the fertile valley to the westward. The valley takes its name from this and other sad experiences.

It is known that men exposed to the sun's direct rays are occasionally made insane, and it is said that one man drove in on a load of borax to the borax works which are located in the valley, during a particularly torrid day, and expired quickly, rigidly grasping in his stiffened fingers a water canteen. Birds in summer rarely try to fly across this alkaline expanse, and when they do, frequently drop dead in midflight.

The animals, such as are found there in the summer, are mostly nocturnal, as might be inferred from the prevailing intense heat. Horned toads and other lizards and snakes constitute the fauna. Cooked meat spoils over night, and raw meat dipped in brine is cured in a couple of hours. The bitter streams of alkaline waters which start from the surrounding mountains are eagerly sucked up and disappear before they flow far into the parched soils of the desert. And yet this region is well known; much better known than many other parts of this country. Occasionally an exploring expedition visits it, prospectors often wander into the valley in search of gold, and one lonely miner kept his cattle high up the mountains for nearly a year. Gen. Frederick Funston, before he had won his honors in the Philippines, was assistant to a government botanical expedition, which in 1891 studied the flora of the desert and the surrounding mountains. The work in the valley was mostly done in the cool of winter, while the flora of the mountains was studied during the warm summer months.

Probably the first scientific expedition to the valley was made by the California Boundary Commission in 1861. Lieutenant Birnie, of Wheeler's Geological Survey Expedition, crossed it several times and made his camp in it for a while. In 1891 the botanical expedition headed by Frederick Vernon Coville, with Frederick Funston assistant, explored this region. It was directed by Hart Merriam. This expedition was made with the co-operation of the United States Geological Survey and Signal Service, and was continued by Mr. John H. Clery, of the Weather Bureau, under the direction of Chief Mark Harrington. It is to the reports of these gentlemen and independent observers that we are indebted for most of the information we have about the valley.

Location.—Death Valley lies in Southeastern California, not far from the boundary line of Nevada and about 50 miles due east of Owens Lake. It lies between mountains in a section of country east of the Sierras. It is inclosed between the Funeral and Amargosa ranges on the east, and the Pinto and Panamint ranges on the west. These ranges are higher than the White Mountains of New Hampshire, and some of the peaks (as the Sentinel) are 9,856 feet high. They are not parts of the Sierra Nevada range. The valley has a length of about 75 miles from northwest to southeast, and at the bottom is only 12 to 15 miles wide at the widest part. Opposite the borax works it is only 6 miles wide.

Below Sea Level.—The valley is one of the few areas in this country that are situated below the sea level. The barometric observations of Lieutenant Birnie show that a large part of the valley is 100 feet below sea level, and some parts much less. Williamson states that the valley is 175 feet below sea level. No doubt parts of the valley are much lower than these figures. There are some sinks along the Colorado River in southern California which are also below sea level, but such localities are few in the United States.

Origin.—This valley was evidently occupied at one time by an inland lake of alkaline water, such as the Carson, Winnemucca and Humboldt Lakes of Nevada are to-day. As it slowly evaporated, the water became bitter from the excess of mineral matter until finally it disappeared altogether, leaving a deposit of salt, borax, etc., which even at this late day can be seen along the eastern border where the slight rainfall has not carried it away.

Borax Works.—Borax is an important salt in the arts. On the eastern side of Death Valley is located the Pacific Coast Borax Company. Some years ago they fenced in 30 acres, to which they gave the rather inappropriate name of Greenland Ranch. In order to raise what crops were needed for food, water was brought from the mountains in barrels and stored in two small reservoirs. With this supply they irrigated and raised several crops of alfalfa a year; by irrigating constantly, a few cottonwood and fig trees were grown. When the works was first started, forty men were employed, who did not stay in the valley in summer. Their season began with September and ended in June.

Climate.—In winter the climate is not hard to bear. On the highest surrounding mountains it is quite cold and snow falls. In the valley it is comfortable. The fauna changes in the winter and jack-rabbits and cottontails visit the valley, as do migrating birds, such as ducks. This wide range of temperature in winter and summer is not unusual. At Yuma, in southwestern Arizona, the temperature in winter falls to 27 deg. F., but in summer it is one of the hottest places in the United States. Even the neighboring Piutes cross the mountains and visit the Death Valley in winter. Early spring and late autumn are not hard to bear, although spring begins earlier there and scarcely any rain falls.

It is the hot stifling summer months that are unbearable. They sap the strength and vitality of the strongest. There was one employe of the Weather Bureau, Mr. John H. Clery, who stuck to it and stayed through the summer, under the most adverse and trying circumstances. His assistant was prostrated by the fearful heat and had to return to Keeler for treatment. Clery made his headquarters at the foot of Funeral Mountains, in a building owned by the borax works. He stayed there five months in the hottest part of the year. The soil near the station was a shifting white sand. No vegetation, except an occasional mesquite bush. The highest temperature reached was 122 deg. in the shade. This temperature was reached for several days, and for three successive days in June, the hottest days he experienced, showed a maximum temperature of 120 deg. F. In July, the hottest month, an average daily maximum of 116 deg. was reached; although this maximum was exceeded in the desert of the Colorado and in parts of India, the average is higher than the averages of those places. We often hear higher temperatures quoted for deserts, but fail to consider they were not taken under official auspices, and that the instruments, not being properly shaded, were affected by reflected and radiated heat. Some of the temperatures quoted for deserts are absurd.

Death Valley, however, is not the hottest place in the United States. The highest temperature ever recorded by official instruments in the United States was at Mammoth Hot Tank, California, in the Colorado Desert. There, in July, 1887, the temperature reached 128 deg. F. in the shade, and on another occasion reached 126 deg. At Yuma, the highest official temperature was 118 deg. There they sleep out of doors, on roofs and porches, in summer, and work is done in the early morning hours before the sun comes up. Much higher figures have been quoted for Yuma, but they are not official. The writer found the Mohave Desert, in southern California, in two different summers, and the Painted Desert, in Arizona, much too warm for comfort, and was reminded of the western stories of the army officer who had been stationed at Yuma for many years. Finally, he passed away, but returned from Hades to Yuma for his overcoat.

Rains are not frequent in Death Valley, and curiously enough, the little rain that does fall generally comes down at night. For the entire period of five months, during which a record was kept and measurement was made with the rain-gage, not quite 1½ inches of rain fell. Many of the showers were so slight that they were merely traces, not enough to be measured by a gage. Agriculture cannot be carried on successfully in the United States without irrigation when the rainfall is less than 20 inches per year. When we consider the fact that in Pennsylvania we have an average rainfall of about 40 inches a year, and that in Oregon the rainfall reaches 100 inches per year, we realize what a slight rainfall the valley has. No records of the rainfall in winter were kept, but if we compare it with the surrounding deserts we can get a pretty good idea. Such a comparison would lead us to assume that the rainfall is from 3 to 4 inches per year. There are other deserts in the United States which in summer show even less rainfall than the Valley. Nearly all the stations in the Desert of the Colorado, in California, show less rainfall than the Valley. Contrary to usual opinion, the atmosphere is not sluggsh and calms are not common. The prevailing wind is from the south and it is frequent, but in summer it is like the breath from a fiery furnace. Comparisons of temperature with oases in the Sahara and desert places in India show that Death Valley is much hotter and drier, and although the maximum may be exceeded in parts of the Colorado Desert and in India, yet the averages are higher.

The cause of the small rainfall is easily understood. The locaton and topography are unfavorable for even a moderate rainfall. A valley below sea level, surrounded by mountains in an arid region, would not receive much rain. The vapor-laden winds from the Pacific lose ther moisture when they are cooled in ascending the slopes of the Coast Mountains of California and the Sierra Nevadas to the westward. The moisture is precipitated as snow and rain long before these winds reach this valley. Hence, when they do reach it, they are already deprived of most of their moisture. It is a well-known fact that cyclonic and anti-cyclonic areas move from west to east; in other words, our weather moves from the west toward the east. Notwithstanding this fact, were it possible for any winds from the east or southeast to reach this valley, they would be dry winds, because their moisture would have been removed by precipitation in crossing the Rockies, and afterward the high plateau country of New Mexico, Northern Arizona, and Utah.

* Journal of Franklin Institute.

CULTIVATION OF INDIA-RUBBER TREES.*

THE latex of the leaves of plants belonging to various families will coagulate more readily than that of the trunk and branches.

If it is true that caoutchouc is obtained by the desiccation of the milky juice of numerous tropical pants, found in various other localities besides Pará, it is no less true that it is only in the latter that the best qualities are found, proceeding from trees called *seringueiras*, belonging to varieties of Hevea. Throughout the province of Pará and along the rivers, as the Jurua, the Pivana, the Madeira and the Jabary, the season for collecting the rubber commences when the waters are low, that is, in June and July, and ends in January and February. But in some of the islands near the city of Pará, particularly the island of Marajo, it may be collected during the whole year.

According to experiments, it has been found that the cultivation of the *Hevea brasiliensis* is not profitable in Ceylon; at the age of eighteen months a million of trees, corresponding to a hectare, do not produce more than 27 kilogrammes of caoutchouc. This slight yield is considered due to the fact that the latex coagulates too quickly, before it can be drawn from the leaves. This is possible, but if the extraction from the leaves can be effected from certain plants only, and not from the Hevea, it is of little consequence. It is comparatively easy to gather the caoutchouc by other processes, but from the trunks of trees, and not from plants only eighteen months in age.

With reference to planting caoutchouc trees in the German colonies of East Africa, it appears, according to the Gummi-Zeitung, that the seeds of the Hevea have germinated well, but the plants have perished in a short time. In other colonies the seeds have not even germinated.

We think that this depends a good deal on the condition in which the seeds have been gathered. According to certain authorities, the seeds do not germinate after the end of two months from their being gathered. This seems to us a little exaggerated. We are now gathering seeds for the purpose of planting in Africa, but we take care to collect them only at the moment when they are falling from the trees, avoiding those which have remained for much time on the ground, as well as those which are not sufficiently mature. With a little practice it is comparatively easy to recognize the fresh seeds by breaking some of them. Seeds with holes are to be rejected.

We preserve the seeds from the action of moisture and of the air by packing them in saw-dust mixed with pulverized charcoal. Notwithstanding precautions, a want of success is always to be feared. It may be deemed fortunate if more than 50 per cent of the seeds germinate and the plants become completely developed.

In general, the owners of the caoutchouc forests, fearful of competition, take little care of the seeds to be furnished. Most of them will even refuse to allow them to be gathered. Others sell some, the love of gain overcoming their jealousy. There are still others who cannot resist opportunities for small incidental profits, but who will furnish seeds unfit for germination by heating them in water. It may appear incredible, but we are well acquainted with an owner in Cameta who acknowledged that he did it. The outward appearance is nearly like that of the perfect seed, but on making a section the difference will be noticed.

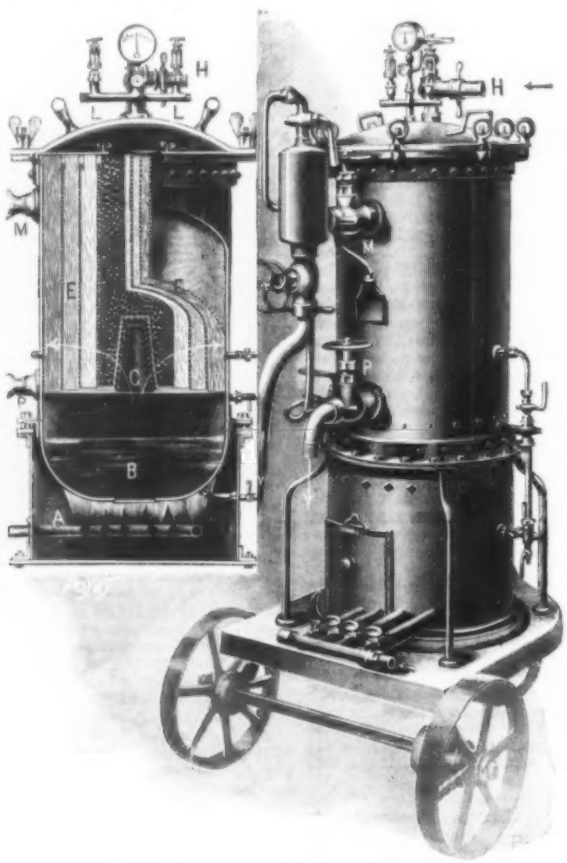
* Condensed from the German of M. Eugene Ackermann in the Tropenpflanzer.

NEW STERILIZING FILTER.

THE filtering of liquids, when it is to be done industrially, is a delicate operation in which it is impossible to take too many precautions. The apparatus used for this operation are numerous, but their maintenance is costly, and it takes a long time to clean them, and it was in order to remedy such inconveniences that M. David Rojat was led to devise a style of filter that, in addition to its efficiency, offers great security by reason of the judicious arrangement of the filtering material, and that, at the same time, may be easily cleaned and sterilized. M. Rojat, by putting to profit the result of his experiments and observations, has arranged his apparatus in such a way that the filteration takes place rapidly, that is to say, in starting from the center of the filter and proceeding toward the periphery, and in traversing several thicknesses of a filtering mass of which the porosity continues to decrease.

The object of such an arrangement is to diminish to a large degree the velocity of the liquid to be filtered —a condition necessary for a satisfactory operation, since the impurities are less easily carried along than if a strong pressure were employed to make the liquid flow with great velocity. It may be remarked, too, that since the porosity diminishes in proceeding toward the periphery, the filtering surface will consequently be increased in measure as it becomes less easily traversed, and this tends to give a more uniform discharge, if we take into consideration the fact that upon reaching these less perous surfaces the liquid is already partially freed from its impurities.

The material adopted as a filter is celluiose, the absorbent properties of which are well known, and which is imputrescible and easily lends itself to combinations with other bodies, such as asbestos, which is capable of reducing its porosity.



THE ROJAT STERILIZING FILTER.

The medium of sterilization is the heat produced by a current of steam at 120 deg. C. Since such steam can be produced easily and at any moment, without the inconvenience of dismounting, there need be no hesitation about sterilizing the filter as often as may be deemed necessary, say several times a day, or even several times an hour, in the course of an operation. This is one of the most interesting peculiarities of the Rojat apparatus, which consists of an upright boiler divided into two parts by a false bottom, *C*, beneath which is situated the boiler properly so called, *B*, into which water is put. This latter is heated at the proper moment by a gas, kerosene, or alcohol lamp, *A*, in order to produce the steam necessary for the sterilization of the filter, *E*, situated immediately above.

A pressure gage, placed between two safety valves, permits of reaching, but not exceeding, the pressure of 2 kilogrammes necessary for obtaining 120 deg. C.

The center of the false bottom carries a double bell provided with apertures arranged in a contrary direction so that it may be traversed by the steam, but not by the filtering materials placed above. These are inclosed in cylindrical baskets, *E*, of perforated iron plate.

The upper part of these baskets is completely closed by a circular plate, open in the center and forming a hermetical joint with the cover, *L*, of the boiler. The tightness is assured by nuts that compress a rubber joint.

The liquid to be filtered enters through the conduit at *H*, and, flowing into the central space, soon fills it. Since it cannot pass through the cone *C* into the lower part, which affords no escape for the air, it traverses radially the different layers of porous material, which are more and more compact in the portions nearest the periphery. Between the last layer and the walls of the boiler a space is left in order to permit of the flow of the filtered liquid, which escapes through *M*.

When it is desired to proceed to the sterilization of the filtering materials, the entrance of the liquid is arrested, and access is given to the air through the cock situated near the pressure gage. Then the liquid contained in the filter is made to flow through the cock *P* placed above the false bottom. The lamp is then lighted, and after the steam, which has become distributed throughout the entire filter, has passed through the open cocks, the latter are closed and the pressure raised until the desired temperature is obtained. After a quarter of an hour the entire mass may be considered as completely sterilized and the work of filtration may be resumed.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

A SMOKE-WASHING APPARATUS.

WE have had an opportunity of witnessing a trial of a smoke-washing apparatus which has been placed on the roof of Romano's restaurant in the Strand, London. A similar apparatus is being fixed in the basement of the Imperial Restaurant in Regent Street, but owing to building operations its application has been temporarily suspended at that place. This is to be regretted, as it is stated that the apparatus does its best work when attached to the lower portion of a chimney, as the fan contained in the apparatus so regulates the draft that chimneys are not required. The inventor is Prof. Giovanni Mugna, of Forli, Italy, who claims for his patent that it deprives the smoke of all those qualities which are objectionable, whether from the point of view of health or of cleanliness. It consists of a metal cylinder at the top of which are openings for the ingress and egress of smoke. A vertical shaft runs through the center of this cylinder, carrying on its upper portion a centrifugal fan and near its lower end a "whirler" or paddle. Smoke is drawn from the chimney into the cylinder by means of the fan and the whirler mixes it with water contained in the bottom of the cylinder. After being washed, the smoke, now almost colorless, escapes from the upper part of the apparatus. This vaporous residue we have not had an opportunity of examining chemically, but the inventor states that it contains only a faint trace of carbonic acid.

The following little experiment was made before us: Pieces of wet blotting paper were held for a few seconds over a chimney leading from a fire where bones and other refuse were being burnt. As might be expected, the paper was quickly covered with soot. The smoke-washing apparatus was then connected with the chimney and clean wet blotting paper was applied over the washed smoke outlet. On removing the paper only three or four smuts were to be seen. The experiment was repeated several times with similar results; it is fair to state that even the few smuts may have been blown from chimneys in the immediate vicinity. Without any great inconvenience it was quite possible to hold the head over the smoke outlet, when only a faint odor resembling burning wood could be perceived. On the residue at the bottom of the cylinder being drawn off it was seen to be a thick fluid of ink-like blackness giving off a strong odor of smoke. The apparatus is worked by a small electric motor of about one horse power. In a building where some sort of motive power is already in use no special motor is required and an electric motor can always be used where a continuous current is supplied. The machine itself only requires to be emptied once or twice a day. We understand that the apparatus is already in use in Italy. The London address of the patentee is No. 8 Denmark Street, Charing Cross Road, London, W. C. We have said enough to show that the apparatus is one that deserves careful trial. If it should prove that it is capable of doing a fair proportion of what is claimed for it by its inventor, it ought to effect an appreciable difference in the atmosphere of any towns where it may be used.—The Lancet.

MEZZOTINTS.*

By CYRIL DAVENPORT, F.S.A.

THERE are two distinct ways of engraving metal plates, so as to be able to make prints from them, the intaglio and the relief.

The intaglio forms of engraving comprise line engravings with the burin, dry point, and all forms of etching with acid.

The relief forms of engraving comprise such blocks as those cut for Pigouchet's "Books of Hours," in the fifteenth century, and those etched by William Blake for the cheap reproduction of his poems, in the eighteenth century. The first of these two kinds of engraving has been most used as far as metal is concerned, as wood is easier and cheaper to make for relief blocks.

To print from a metal plate, engraved in the intaglio manner, a strong pressure is required, but to print from a relief block only a slight pressure is required,

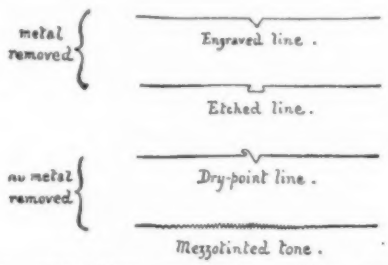


FIG. 1.—DIAGRAM SHOWING THE MICROSCOPIC FORMS OF LINES CUT ON METAL.

and in either case an impression can be made either in white or in black, according to the manner in which the intaglio or the relief block is inked and printed.

A mezzotinted metal plate is at first clearly an intaglio, but as the rocking proceeds and becomes closer, the resulting burrs are actually raised above the level of the normal surface, and to that extent the plate becomes a relief block. Like a relief block also it will print black, and as the surface is scraped away or burnished down, so also the resulting effect on the print is toward white.

The difference of the commoner lines made on a metal plate for the purpose of reproduction by printing shows clearly on one of my diagrams (Fig. 1). The upper line is a clear cut out of the surface of the metal, a thread of corresponding size to the cut being removed. The next line shows the effect of an etched line on metal; in this case the metal is first covered with a thin coating of wax, specially prepared, and upon this a design is marked with a sharp point or needle cutting down to the copper. Then the plate is dipped in a solution of nitric or other acid, which attacks the metal in the places where the wax coating is removed and corrodes it away rapidly. If the plate is left too long in the acid this will undercut beneath the wax and make broad lines. I mean to say that the acid will, of itself, give other effects than those intended by the etcher, and of course it removes some metal. The next shows a dry point line, no metal being removed, but only a scratch made, throwing up at one side the same amount of metal as is moved by the hard scratching point; the action is similar to that of a plough driving a furrow and throwing up a ridge. On the metal this ridge is called a burr, and it has a very important effect on a print as it catches a quantity of ink behind its sheltering crest, and produces a thick, soft effect on the paper.

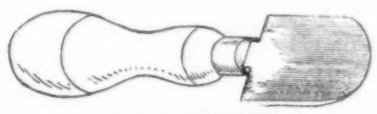


FIG. 2.—ROCKER.

The mezzotinting process removes no metal, except by accident, as for instance, when the rocking is carried too far, then the burrs will get so small that they are apt to tumble off and leave only a roughened depression.

The most distinctive tool used in the process of mezzotinting a metal plate is called a "rocker." It resembles a small spade, and is beveled at the broad end, which has a curved outline (Fig. 2). The flat side of the rocker is channeled finely or coarsely according to the wish of the engraver, and whenever the tiny teeth get worn down or perhaps broken in places, it is easily remedied by simply sharpening the edge as if it were a chisel, the effect of the channeling being to produce a toothed edge resembling that of a tooth-comb. In the early times of mezzotinting rockers were made so as to be used in the hand, but of late years an arrangement with a short pole has been substituted, and with this simple appliance it is much easier to roughen a plate than it was when the rocker was handled like a gimlet (Fig. 3). The rocker, as now used, is no doubt a development from a roulette. The first mezzotints were roughened by means of roulettes held in the hand. They were of many different forms, ranging from the small toothed wheel, like the rowel of a spur, with a single line of points, to the broad disc, resembling a small garden roller, which was used by Prince Rupert and his followers. Between these two extremes the varieties of roulettes

* Paper read before the Society of Arts.

were many, and it is likely that each mezzotinter designed the form which he preferred for his own use (Fig. 4). Roulettes were first used to roughen metal plates by L. von Siegen, who found that they were able to produce an effect, rapidly and easily, which, if done point by point in the *pointillé* manner, would be slow and difficult.

The most valuable use of a roulette is not in its use alone, but as an accessory to rocked work; being quite small it is invaluable to deepen the roughening in particular places, and it is also of great use in the event of too much scraping having been accidentally done. In former days mezzotinters generally laid their own grounds, very often only working them where required, but now the whole of the plate is evenly covered with the rough grain, and this laying of a mezzotint ground is, moreover, done professionally, so that a modern engraver works on a ground with which he

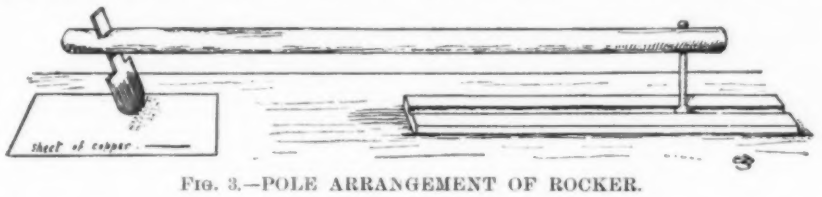


FIG. 3.—POLE ARRANGEMENT OF ROCKER.

is in doubtful sympathy. I think that the professional laying of a mezzotint ground militates much against the true art value of the work of any engraver who works upon it. It is, however, a slow and tedious process, the plate having to be crossed some eighty times, and in these days of hurry we must perforce forgive it, as very few mezzotinters could, or would, spare the time to do it for themselves as they ought to.

The next important tool used in the production of a mezzotint is a scraper (Fig. 5). Like the rocker, the scraper is of hard steel. It is a short, sharp cutting edge set in a handle, and by its use the mezzotinter scrapes away the roughness on his rocked plate as much as he considers necessary. If the scraping is carried far enough all the marks made by rocker or roulette can be erased, and every scrape, when printed, shows more or less as a light place. Scrapers should be very carefully kept dry, as the sharp edge soon loses its value if any rust gets on it, and instead of a clean sharp cut, it makes a jagged scratch. The main difficulty in engraving a mezzotint is in the use of the scraper, so much so that the phrase "scraped" by so-and-so is often heard referring to the engraver. Indeed it may almost be said, especially now that the grounding is usually done professionally, that the art of the mezzotinter consists of his skill with the scraper alone. There is, however, one more instru-

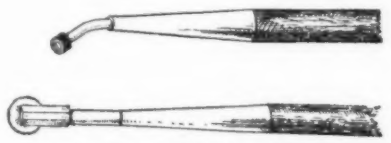


FIG. 4.—ROULETTES.

ment that is a dangerously powerful one. Dangerous because it can be made to do easily work of the same kind as can be done with some difficulty with the scraper. This instrument is a burnisher, and the work of flattening down the small roughnesses which are left by the scraper falls to its lot (Fig. 6). A burnisher is a more delicate instrument than even a scraper, because its own function requires a perfectly clear polished surface to work with. If there is the smallest speck of rust on a burnisher it is not safe to use it. Early mezzotinters were by no means so careful about this as they might have been, and the result can be seen in numberless instances where places intended to be pure white show hair marks along their length. Such marks are probably due to small inequalities on the surface of the burnisher.

A hard steel burnisher acting on soft copper which has been rocked, is capable of polishing out all marks, and consequently of creating a form on the plate which will show white upon a print. Such a small point will be, however a depression on the copper, and although polished, nevertheless a layer of ink is always likely to remain in it, so it is advisable to go over all such points with a soft wooden point armed with a little whitening, in order to get every atom of the ink out. Such white spots can often be seen on the points of noses, and about the eyes, and for greater effect they are also often helped by the near neighborhood of burin work—sharp and black.

FIG. 5.—SCRAPER.

Practically, then, a mezzotinted plate is burred all over, and the art work upon it is done by means of scraper and burnisher, the effect of each of which is toward lightness. The more it is worked upon by these two instruments the lighter the print will be, and in a few places where greater strength of tone may be required, a roulette can be effectively used to restore the requisite darkness. Many fine mezzotints owe much to line engraving, dry point, and etched work, but when any of these are found in any considerable quantity the engraving should properly be called in "mixed manner."

Much importance attaches to the inking of a mezzotint plate, more importance than has been credited to it. A bad inker and printer cannot make a good print from the finest plate, and a good inker and printer can make a decent print from a very bad plate.

Mezzotints were printed in color at an early period in their history. Joannes Teyler, Professor of Mathematics in the military college at Nimeguen, at the end of the seventeenth century, printed several of his plates in color, inking each plate carefully in the proper place with properly colored ink. Then, a little later, J. Christophe Le Blon began three-color work. He engraved a separate plate to carry each color, and used red, yellow, and blue, with sometimes a key-plate in neutral tone. At least one of these plates was mezzo-tinted, but they are sometimes etched. He described his process in a tract entitled, "Coloritto," published about 1723.

The finest color work of this kind is now done for the Société des Amis des Livres, at Paris; the registering of their plates is marvelous, and the effect beautiful. In England, Mr. Cadbury Jones endeavored some short time back to introduce color printing for metal plates in the manner of Joannes Teyler, the plates being inked in the different colors, but his endeavors did not meet with the success they deserved.

The early exponents of mezzotint work were all amateurs. The first mention of it is contained in John Evelyn's "Sculptura," published in London in 1662, and he says it was described to him by Prince Rupert. Prince Rupert engraved a small head of "The Executioner," taken from the larger plate, for Evelyn's book, and this is, I believe, the first mezzotint ever published as a book illustration. Evelyn does not describe the process, but it was described by Alexander Browne in a book called "Ars Pictoria," published by him in 1669. In this description no mention is made of a scraper, but the directions advise the use of a burnisher for lightening the plate.

Prince Rupert was for a long time considered to be the inventor of the mezzotint, but it is now known that Ludwig von Siegen, an officer in the Hessian army, used a system of engraving which ultimately developed into true mezzotint. An excellent account of Von Siegen and his invention can be found in Léon de Laborde's classic "Histoire de la Gravure en Manière Noire," and in this book is a facsimile of a letter which was sent to the Landgrave of Hesse, accompanied with a print of a portrait of his mother the Landgravine Amelia Elizabeth, executed in the new manner. This print, of which I have an excellent slide, is, in my belief, all worked by means of a small single-line dotting roulette. Von Siegen's letter is dated August 19, 1642, and his print is considered to be the first important mezzotint. In places where the roulette has been used closely and strongly, a certain velvety effect is found, and this no doubt, being entirely new, gave the idea a start, which was followed up by Prince Rupert and others, and eventually became the chief characteristic of mezzotint work. I take it, however, that in all these early prints the mezzotinting or rouletting has only been done in the places where it was wanted, so that scraping was not necessary, whereas in a true mezzotint the rocking or roughening is systematically done all over the plate and afterward cut away by means of a scraper as required. In Von Siegen's letter there is no mention of a scraper.

Prince Rupert learned the new art from Von Siegen, and rapidly improved upon his master's work. Several of his plates are powerful and cleverly managed, the mezzotinting is only put where it is wanted, and there is little or no use of the scraper. The use of the burnisher on metal was well known in Prince Rupert's time, and any corrections he found it necessary to do upon his plates were probably done by means of this instrument. Prince Rupert most likely used a roller with a grooved surface to roughen his plates, and some of them show broad curved impressions from such an instrument. The early mezzotinters were not only amateurs but Dutchmen as well, the Canon von Fürstenburg being a contemporary with Prince Rupert. Wallerant Vaillant, a Dutch portrait painter, assisted Prince Rupert, and himself worked a few plates in the new manner, but neither his work nor that of the Canon was particularly good. Under one of his plates, a portrait of Prince Rupert, occur the words "Prins Robbert, vinder van de Swaarte Prent Konst." The Van Somers and Abraham Blooteling also worked in England; in the case of Blooteling this is particularly fortunate, as his work is in every way excellent, and in consequence of his working here so largely, we count him in the list of English mezzotint engravers. Blooteling was the first to perceive the great artistic possibilities of the new process of engraving, and he taught an assistant, Blois, to prepare his grounds, and these are well and evenly done. Also Blooteling used the scraper, which does not seem to have been used before in the particular way of lightening on all-over darkened plates. The question naturally occurs here as to whether it is possible to say from a print whether a pale place on a mezzotint has been produced by means of a scraper or by a burnisher. I have not time now to go into this question, but will only say that there are certain signs on all such pale places by which it can be said, with some certainty, how they have been produced. Blooteling came here in 1673, and his work quickly became much admired by line engravers, many of whom took up the new process as an amusement; but gradually its powers became more and more appreciated until at last our native engravers became so pre-eminently skillful that mezzotinting was known as an English art.

The early mezzotinters engraved principally after their own drawings, but very soon they became interpreters of the work of other men. At the same time, in a first-rate mezzotint, we must acknowledge a con-

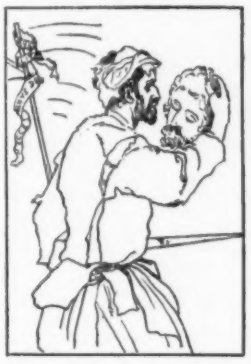


FIG. 7.—"THE GREAT EXECUTIONER," ENGRAVED BY PRINCE RUPERT. 1658.

siderable amount of original merit, in addition to the skill of the copyist.

Like the Dutch, the first English engravers in mezzotint were amateurs, the two first being William Sherwin and Francis Place. Sherwin counts first because he dated one of his prints, a portrait of Charles II. "1669," and Place dated none of his, though they may have been done earlier than Sherwin's. Isaac Beckett may be considered the first English professional mezzotint engraver. He worked about 1670, and took pupils, among whom was John Smith, afterward one of our most famous engravers, and a very prolific one.

After Isaac Beckett, English engravers in mezzotint increased rapidly in number, and they gradually took the art away from its Dutch votaries; at the same time, the foreigners remained here for some time and executed much good work. Among these were some well-known artists—Vandervaart, Verkolje, Van Bleek, and Van Haeken.

During the eighteenth century we do not find the same preponderance of Dutch workmen, but the English names occur almost exclusively. In the beginning of the century John Smith worked most successfully, and was followed by a numerous band of famous engravers,

FIG. 6.—BURNISHER.

many of whom, owing to the revived appreciation of mezzotints, are now well known.

John Faber, junior, is best known for his engravings after the portraits of the members of the Kit Cat Club painted by Sir Godfrey Kneller. The club was originally political, but soon lost that distinction, and the club-room in Jacob Tonson's house at Barn-elms was too low to admit the usual full-length figures, so Kneller made his canvases 36 by 28 inches, and christened this size of picture after the name of the owner of the original meeting-house, Christopher, or Kit Cat.

About 1714 George White inaugurated the introduction of etching into the mezzotint world; he strongly etched his subjects before putting in the mezzotint tones. This principle was afterward much followed especially in the case of large subject pieces.

A large proportion of eminent eighteenth century mezzotint engravers came from Ireland, the most eminent of whom was James MacArdell. He largely engraved after Sir Joshua Reynolds, who himself declared his

FIG. 8.—"MISS JACOBS," ENGRAVED BY J. SPILSBURY. 1761.

This mezzotint received the premium of fifteen guineas from the Society of Arts, in 1762.

belief that he would be immortalized by MacArdell's work. Then there was his fellow pupil with Brooks, Richard Houston, and Thomas Frye, who engraved large portrait heads after his own drawings about 1740. Other noted Irish engravers were E. Luttrell, Thomas Beard, W. Baillie, John Murphy (who, unfortunately, has only left a few rare plates, all very

fine). J. Brooks, Ed. Fisher, Ch. Spooner, J. Dixon, and Richard Purcell.

These engravers and their English contemporaries of the eighteenth century have left an unequaled series of magnificent portrait engravings after the works, particularly of Sir Joshua Reynolds, P.R.A., J. Hoppner, R.A., Sir T. Lawrence, P.R.A., G. Romney, and T. Gainsborough, R.A., all notable for the beauty of their female types, and in the matter of subject pictures they have engraved chiefly after the works of G. Morland, W. Hogarth, Benjamin West, P.R.A., and J. Zoffany. Among the most notable of the English mezzotinters of the latter half of the eighteenth century, Valentine Green is one of the best known. He had several pupils of whom John Dean, one of the most delicate of engravers, is perhaps the most eminent. In 1777, Richard Earlom engraved a set of mezzotinted etchings after Claude Lorrain, one of which I have to show you as an experimental slide. J. R. Smith, son of Smith, of Derby, was one of our greatest engravers in mezzotint; he made some plates after his own drawings, but is chiefly known for his beautiful interpretation of the works of Sir Joshua Reynolds.

J. Walker, Jonathan Spilsbury (Fig. 8), and C. Turner were all first-rate engravers in mezzotint. C. Turner was a relation of J. M. W. Turner, our greatest landscape painter, and he assisted his eminent kinsman in the engraving of some of the plates of the "Liber Studiorum."

During the early part of the nineteenth century portraiture still maintained its supremacy, but the application of mezzotint to landscape art is characteristic of a later period. S. W. Reynolds, a pupil of J. R. Smith, was a very successful and skilled engraver. He engraved a series of 357 small mezzotints after the work of Sir Joshua Reynolds. These small plates form an illustrated index of Sir Joshua's work as far as S. W. Reynolds could find it. They are, however, not quite satisfactory, as the process of mezzotinting does not suit very small work any more than it suits very large work. S. W. Reynolds also engraved several plates after his own drawings.

William Say is noteworthy among the earlier nineteenth century engravers, as he executed a small portrait of Queen Caroline in 1820 which is the first mezzotint engraved upon steel. Underneath the first proof made from this plate is a note: "This attempt to engrave on steel was made in 1820.—W. Say." The portrait is not very pleasing, but many mezzotinters have worked in steel since with much success. No doubt the great durability of steel is much in its favor, but there are several technical difficulties connected with its actual use for engraving upon directly, and this has led to the modern evil of mezzotints engraved upon copper being covered with a thin film of steel, so as to give them a lengthened life. From such a steeled plate an infinite number of identical prints can be drawn. From mezzotints engraved upon a copper plate about fifty prints of the finest quality can be drawn, after that the plate begins to deteriorate. The beauty of a print from a copper plate is a rare beauty; that of a print from a steeled plate never can be rare, neither is it equal in quality to a print made before the steeling operation was done. There are certain checks upon the indiscriminate production of prints from steeled plates, but I doubt if they are reliable.

J. M. W. Turner no doubt admired R. Earlom's etched mezzotints of Claude Lorrain's "Liber Veritatis," and it appears likely enough that this gave the former the idea of his "Liber Studiorum," issued in parts between 1807 and 1819. Turner made small sepia sketches, from which he etched the outlines on copper, and then had the light and shade filled in by various engravers in mezzotint or aquatint. Turner himself mezzotinted some of them. Of their kind they are the finest things that have been done, and they have always been favorites with collectors because of the difficulty of getting a complete set of proofs. Turner issued the prints in sets, "prints" and "proofs," but, as a fact, they were all mixed, so that to get a real set of proofs together involves a long search and much tribulation.

Quite recently Mr. Frank Short, best known as an etcher, produced a few etched and mezzotinted plates from sketches by Turner, done in the same manner as the old ones, to which they clearly approximate in every way.

T. G. Lupton was the first mezzotinter to work largely upon steel, and he chiefly engraved landscapes. For his success in working this process upon soft steel he received the medal of the Society of Arts in 1822. His work is, I think, the most pleasing of any mezzotinted landscapes; this is partly due to the fact that he used a brown ink by preference. Brown ink is troublesome to manage on steel. I think, altogether, that landscapes are hardly satisfactory in mezzotint, but that the finest effects are to be found among the splendid series of full-length portraits of ladies, after Sir Joshua Reynolds, or one or other of the artists of his period. Three-quarter lengths are perhaps the more usual form in portraiture, both in portraits of men as well as women, but there is a completeness about a full-length, which is necessarily wanting in a portrait representing any lesser degree.

David Lucas is particularly known for his interpretations in mezzotint after the landscapes of John Constable, R. A. They are, as a rule, too dark, and are printed in black ink. Sometimes pleasanter prints have been drawn from a worn plate than from a new one, as they are paler. At the same time the original pictures are dark, but I think that if Lucas had used a browner ink, as Lupton did, his landscapes would have been pleasanter. He nearly always engraved on steel. Lucas died in 1881.

Samuel Cousins brings us up to modern times; he gave up work in 1883. His work is always delightful. In 1814 he was apprenticed to S. W. Reynolds, and presently set up for himself at 104 Great Russell Street. He engraved largely both portrait and subject pieces, and his plates are very fully etched before the mezzotinting is put on them. His style may be considered as the modern one, as it has formed the keynote for most of his successors. A large plate, engraved by him, after Landseer, "Bolton Abbey," executed quickly and very effectively in etching and mezzotint, is supposed to have given the death-blow to the old-fashioned, slow, and expensive process of line engraving. It was published in 1837. He engraved largely upon steel.

Mezzotints can now be very efficiently copied by means of photogravure, a form of etching, and probably this process may yet attain greater perfection. At present it leaves something to be desired in the matter of brilliancy—there is too much loss of light. But a photogravured plate can be worked over to almost any desired extent by rocker or roulette, burnisher and scraper, so that it can be made almost identical with the original. A photogravure made direct from a painting is often very good, but here, again, it generally needs a little skilled handwork in weak places.

What with steel-plating of copper plates, and the direct competition of photographic processes, it is probable that mezzotinting as a high art has had its day. Except for the work of a very few living engravers of the first rank in this method, mezzotinting has already reached its highest development, and we may well be proud of the beautiful examples which have been left to us by MacArdell, Valentine Green, J. R. Smith, and others of their period, men whose talent has been great enough to earn for their particular art of engraving the title of *la manière anglaise*.

ELECTRICAL NOTES.

The Mayor and Aldermen of the City of Launceston, Tasmania, are prepared to receive tenders for the supply of 500 or more electric meters. Specifications and conditions of contract in duplicate may be obtained on application to Mr. William Corin, City Electrical Engineer, Launceston, Tasmania, or to Messrs. John Terry & Co., 7 Great Winchester Street, London, E.C., England, on payment or £2 2s., which sum will be refunded on receipt of a *bona-fide* tender. Sealed tenders, indorsed "Tenders for Supply of Electric Meters," must be addressed to Mr. C. W. Rocher, Town Clerk, Town Hall, Launceston, Tasmania, and lodged in his office not later than 12 o'clock noon of Monday, September 28, 1903.

In L'Industrie Electrochimique the Becker and Cowles processes of electrically manufacturing sodium are described. The Becker process depends on the decomposition of sodium chromate, tungstate, etc., and carbon in an electric distillation furnace, the sodium being distilled off and being condensed afterward, while metallic chromium remains. By treating mixtures of different salts and oxides, it is possible to produce alloys. The Cowles process depends on the reduction of sodium aluminate with the production of aluminium carbide and metallic sodium, which distills off and is condensed as above. If iron or copper is added to the sodium aluminate, ferro-aluminium or cupro-aluminium is obtained instead of aluminium carbide.

The results of some interesting experiments on the leakage currents from electric tramways to gas and water pipe systems are described by A. Larsen in a German contemporary. For the purpose of the tests, pieces of iron tubing were placed in earth, and currents passed from them through the earth to surrounding cylindrical iron mantles; the earth was moistened from time to time, and in some instances impregnated with salt. The amount of corrosion was determined by scraping and reweighing the pieces of iron tubing from time to time. From the data it appears that the loss of weight of the tubes per ampere-hour was independent of (1) the current density, (2) the voltage, (3) the nature of the iron (whether wrought or cast), (4) the presence or absence of salt, (5) the character of the current (whether steady or intermittent). The electromotive force of polarization was proportional to the working electromotive force, and manifested itself as an apparent increase in the resistance of the earth.

A bulletin was recently issued by the United States Census Office on the statistics of the street railway industry of the United States, which is made the subject of some elucidating remarks by the Electrical World and Engineer. The totals which are presented in this report are truly imposing, revealing tremendous advances in the last ten years, with consequent benefit to the public without a single drawback worthy of the slightest consideration. It is interesting to note that the total capital obligations of the industry represented at the time the figures were compiled last year, a total of not less than $2,300,000,000, with 22,589 miles of track and over 60,000 passenger cars. One of the most interesting figures which emerges is that of earnings, the companies showing gross receipts from operation of $247,553,000, of which all but $14,000,000 was received from passengers. The total receipts from passenger earnings of the steam railroads of the country for the same annual period were only $393,000,000. Upon the basis of the population of 1900, the average number of street car rides per inhabitant was 63 in 1902, or just double what it was in 1890. It appears upon this basis and upon the figures of earnings, that the average expenditure per head in the United States for street railway service is just about $3, and that the enormous number of 4,809,554,438 fare passengers were carried in 1902. It is needless to say that this enormous expansion of traffic and utility is wholly due to the introduction of electricity. It is also interesting to note that the system for the 797 companies reporting the figures, out of 817, showed 133,641 wage earners, whose income amounted to $80,000,000. It is altogether inconceivable that but for the aid of electricity the street railway system of the country would have been able to give employment to so many men of a higher grade, and under better conditions, than those who once drove horse cars. Equally interesting are the figures with regard to motive power, car equipment, etc., showing a total power house capacity of 1,204,238 horse power of dynamos, and a daily kilowatt-hour output of 6,249,910, representing roughly a total operation of about five hours daily of all the apparatus reported. And yet great as these figures are, it is evident to the most casual observer that ten years hence the statistics are likely to show as great an increase as those of 1902 have shown over those of 1890 in the application of electricity to the transportation of the traveling public in cities, as well as outside city limits.

MISCELLANEOUS NOTES.

Herr B. Weinberg, of the University of Odessa, has collected about 130 of the more trustworthy values of the solar parallax as obtained by different observers, using various methods, since 1825, and has discussed them in a paper communicated to the Astronomische Nachrichten. From the discussion he has obtained 8.8004 inches with a probable error of .00243 inches as his final value for this constant.

P. Lemaire has examined the bark of *Richeria grandis*, which, under the name *Chalufouria racemosa*, "Bois bander," "Bois d'homme," and many other names, has a wide reputation as an aphrodisiac. The author finds, however, that this is ill-founded. It contains no alkaloid or any other active principle. Petroleum ether removed from it a crystalline body, occuring in hexagonal scales melting at 237 deg. C., but which were devoid of physiological action. Besides this, nothing but reddish brown coloring matter, tannin, and glucose were isolated.

The term "mineral zone,' as used in contradistinction to a "mineral vein," refers to the fact that a mineral zone is not always clearly defined, as by walls. The mineralization may extend along one or both sides of a fissure having no defining limits, while a vein is presumed to be situated wholly within definite bounding planes and may be easily distinguished from the adjoining country rock. In a zone of mineralization the mineralization may gradually disappear as distance from a central crack or fissure increases until it ceases altogether. A mass of rock within which occur several veins or ore bodies is also often referred to as a zone.—Mining and Scientific Press.

In the Journal of the American Chemical Society, H. W. Hillyer discusses the physics and chemistry of soaps and their cleansing power. From study and experiments he draws the following conclusions: "The cleansing power of soap is largely or entirely to be explained by the power which it has of emulsifying oily substances; of melting and penetrating into oily textures; and of lubricating texture and impurities so that they may be removed easily. It is thought that all of these properties may be explained by taking into account the low cohesion of the soap solutions and their strong attraction, adhesion, or affinities to oily matter, which together cause the low surface-tension between soap solution and oil."

Seidlitz salt is one of the many old names for magnesium sulphate, says the Druggists Circular and Chemical Gazette. It has at various times been known as seidlitz salt, ogra salt, canal salt, bitter salt, cathartic salt, English salt and Epsom salt. Its earlier source was from the salt springs of Epsom in England and from this fact it took its last two names. For a long time sea-salt makers supplied the markets of the world. They procured it as a by-product in the making of salt. The bitter water that remained after the table salt had been crystallized out was found to contain it. Now it is chiefly procured from such minerals as dolomite, silicious magnesium hydrate, and schistose rock containing the sulphide of magnesia. Many medical men deem it our best saline cathartic.

The chief constituent of true cinnamon oil as well as oil of cassia, is known to be cinnamic aldehyde. Other known constituents are phellandrene and eugenol, but a mixture of these three substances does not yield a product having the delicate and characteristic odor of cinnamon. Schimmel & Co. have patented a method for producing an oil closely resembling that of true cinnamon, which involves the use, in addition to the three substances mentioned above, of normal amyl-methyl ketone, nonylaldehyde, cuminaldehyde, caryophyllene, linalool, and its butyric ether, cymol, benzaldehyde, phenyl-propyl aldehyde, furfurol, pinene, and eugenol methyl ether. All these have been recognized as constituents of true cinnamon oil, and the first six are of most importance in reproducing an odor resembling that of the natural product.

There are 159 omnibus routes in London, of an aggregate mileage of 757. In the central streets the 'buses form more than a third of the vehicular traffic. Altogether they carry 480,000,000 passengers a year. At some points nearly between 600 and 700 'buses pass every hour, and the traffic has not been seriously interfered with by the tubes. The Central London has affected the 'buses, but new routes are always being openell up. Omnibuses are slow, the fares are high—35d. per head more than tramway fares. Unlike railways and tramways, they have no preferential tariff for workmen, yet the present inconvenient, uncomfortable 'bus, or its successor, the motor 'bus, is likely to remain a familiar sight in London. Electric cars and tubes will compete in the main routes, but the 'buses will open up new routes in the outer zone, develop cross routes, and, by adapting themselves to changed conditions, maintain a place in our means of locomotion.—Municipal Journal.

Prof. E Dorn, of Halle University, communicates to the Physikalische Zeitschrift an interesting observation lately made by himself. Having introduced about 30 milligrammes of radium bromide in a Sena glass bulb, that eventually was sealed, the author wanted to open this bulb six months afterward. Now, at the very moment of the file scratching the surface of the glass, the tube was pierced by an electric spark, producing quite a considerable noise. Though the author stood by the window, on a bright summer afternoon, he was struck by the intensity of the spark, the noise being so strong that the mechanician of the laboratory, who stood in the midst of the room, would ascribe it to the discharge of an induction coil, which, by the way, was not even connected to the battery. In order to explain this singular phenomenon, the author presumes that the negative ions, having traversed the walls of the bulb, had escaped outside, leaving the positive ions inside of the bulb. On the outer surface of the latter, there had next occured an accumulation of positive electricity, derived from the atmospherical air ionized by the radium emanation or conveyed by surface conduction. As Prof. Dorn would hold the bulb with the left hand, and the metal of the file with his right, the conditions necessary for a discharge were given.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

How to Increase Our Exports to India.—I have before called attention in my reports to the necessity of having more rapid and reliable freight lines between New York and Calcutta in order to increase our trade with India.

The Bucknall Line, whose steamers sailed at irregular times and touched at so many ports—taking about fifty days in making the passage—has been withdrawn, and now the only way to ship goods from New York to Calcutta is via Glasgow, Liverpool, London, or Naples, and the goods are frequently delayed a long time waiting transshipment. Thus it often happens that they are not received until after they are required and are consequently left on the hands of the importers.

India has been neglected by our exporters, so that out of $250,000,000 worth of goods imported annually the United States last year had only about 1.5 per cent of the trade, while the United Kingdom had about 67 per cent and Germany, France, and Belgium, in the order named, the larger part of the remainder.

About 50 per cent of the imports are cotton goods and the next largest are iron and steel manufactures. In both of these the United States should be able to compete successfully with any other country.

If a direct line of steamships were established between New York and Calcutta, sailing regularly—not less than once a month, and oftener when the trade increased to warrant it—the passage not to be more than forty days, so that importers could rely upon receiving their goods at specified times; and if our exporters would put active, capable men in the field to exploit the markets of the country, our trade would be increased many fold within a very short time.

There are no restrictions on trade in India, and there is no reason why our exporters should not compete successfully with those of the United Kingdom, especially in cotton goods and all manufactures of iron and steel. The only obstacle is the want of more rapid transit for their goods and more determined efforts to secure the business.

Such a steamship line as suggested would be sure to receive return cargoes, as our imports from India are now large and constantly increasing, amounting to about $35,000,000 last year.

There is such an opening in India for the expansion of our trade that I cannot urge too strongly that the necessary means be adopted to secure it.—R. F. Patterson, Consul-General at Calcutta.

Data Compiled by the Bureau of Statistics.—India's commerce is as interesting to Americans as it is to any people except, perhaps, the Indians and English. When it is remembered that India ranks sixth among exporting and tenth among importing countries, the volume of her trade may be partially measured. Last year India's exports were valued at $403,000,000 and her imports at $264,000,000. Of India's $264,000,000 worth of imports, 36 per cent were cottons. Next in the list of imports are iron and steel products, which form 12 per cent of the total. Third in importance in the list of India's imports is mineral oil, 5 per cent of the total imports.

Thus, of India's imports more than 50 per cent are of a class that might be called indigenous to the United States, and the greater part—fully three-fourths—of the entire list is made up of a class of articles successfully produced by and exported from the United States; and yet our exports to India amount to less than 2 per cent of the imports of that country.

The United States imported East Indian goods in 1892 to the value of $24,773,107 and in 1902 to the value of $48,421,218. The exports thither from the United States in the years indicated were $3,674,307 and $4,621,876, respectively. The most important imports to the United States from the East Indies are: Jute manufactures, $10,000,000; jute, unmanufactured, $4,000,000; hides and skins, $8,000,000; gums, $2,000,000; etc.

India's Growing Importance.—India has advanced from $28,000,000 in imports in 1840 to her present $264,000,000; her exports have increased equally fast, or from $51,000,000 in 1840 to $403,000,000. Of the total foreign trade in 1902 ($667,000,000), Great Britain naturally supplies the largest part. Her share was 64.5 per cent; the British colonies, 5.3 per cent; or a total British trade of 70 per cent. Following Great Britain, but a long way behind, come Austria-Hungary, with 4.8 per cent; Russia, 3.9 per cent; Germany, 3.7 per cent; Belgium, 3.7 per cent; China, 2.2 per cent; France, 1.7 per cent; and the United States, 1.4 per cent. In 1899 the United States supplied 2 per cent of India's imports; in 1900, 1.7 per cent; in 1901, 1.6 per cent; and in 1902, 1.4 per cent. Of India's exports, England's share was not so large as her share in the imports, while the share of the United States therein was very much larger than her share in the imports. Of the total exports of India in 1902 ($403,000,000), Great Britain took 25.1 per cent; the Straits Settlements, Egypt, and Ceylon, 13.9 per cent; China, 14.5 per cent; Germany, 8.4 per cent; France, 7.3 per cent; and the United States, 6.9 per cent.

Carriers of India's Commerce.—Of the vessels entering and leaving India's harbors last year, 79 per cent sailed under the British flag. If the tonnage is taken into consideration, it will be found that Great Britain did 81 per cent of the total trade. It is officially reported that German and Austrian tonnage are rapidly growing. Germany's increase is indicated by the fact that her figures were 209 ships for 1900 and 270 for 1902; Austria's, 131 in 1900 and 164 in 1902. The French figures fell from 155 in 1900 to 149 in 1902, and Norway's from 82 to 78.

American Interests and Opportunities in Siberia.—Agricultural Machinery.—Agricultural machinery and appliances of American manufacture, as is well known, are widely used in the pre-Amur country. For these goods—especially for harvesting machinery—there is such a demand that private firms cannot fill the orders.

The Ministry of Agriculture, desiring to aid the local peasant proprietors, has set apart a fund to establish at Habarofsk a government warehouse for agricultural machinery and appliances. It has directed the pre-Amur management of imperial properties, as its representative in this section, to organize such an establishment. As the management intends to operate to a large extent in American goods, it is at present greatly in need of information from competent sources regarding the purchase and importation of such goods from the United States. The management therefore requests information on the following points:

(1) The addresses of firms dealing in agricultural machinery.

(2) The addresses of firms manufacturing such machinery, with price lists and catalogues.

(3) Lists of steamships plying between the United States and Vladivostock.

(4) The best terms of purchase of such machinery.

Agents of several firms are on the ground, or have been. In the past, business firms hereabouts have done good work and accomplished excellent business results in these lines. No traveling agent, however, spoke Russian and no catalogues or prices, excepting those reprinted by agents here, have been in the Russian language. Some catalogues of agricultural-implement firms are on hand, but only a few—none with bottom prices. These should be forwarded, even though in English. What is needed is prompt replies to this office of lowest quotation, cash or time (preferably the latter), and a brief catalogue in Russian, of which several copies are needed. Meanwhile, any printed matter sent should be mailed via Moscow, "R. T. Greener, commercial agent, U. S. A., Vladivostock, please forward." Telegraphic addresses of many firms are at hand and some catalogues. What is needed is as complete a list as can be furnished, with lowest prices, prospective freight charges, and statements as to cash or time.

Flour Mill.—The American firm of Clarkson & Co., established here some five or six years, has made application to the local authorities for a 24-year lease of 54 acres of land owned by the city at Cape Firsoff, near the Ussuri Railway, 6 miles from the city, at a rental of $309 per year for the first twelve years and $618 per year for the last twelve years. The firm proposes to erect there a flour mill, provided with all the latest American appliances. The buildings will be 4½ stories, with accompanying lodging houses and warehouses and a branch railroad to connect with the main Ussuri line.

It is proposed to invest $51,500 in this enterprise, which is said to have official countenance if not financial support. At the expiration of the term of lease all the buildings will become the property of the city. This firm already has several coal and gold mines under exploitation, a saw mill which runs in connection with a sash and blind and door factory, a contract for granite work on one of the new wharves, and a lease of some supposed valuable mineral lands near St. Olga Bay, of which great expectations are expressed. This firm has also branch offices at Nagasaki, Port Arthur, Tientsin, and Harbin.—R. T. Greener, Commercial Agent, at Vladivostock.

American Competition in South Africa.—The Central Bureau for Preparing Commercial Treaties of Berlin publishes the following, under date of June 15, 1903:

"It has already been pointed out in the press that the impending differentiation of non-British imports to South Africa is even more severe on America than on Germany.

"In the fiscal year ended June 30, 1902, America exported to South Africa goods to the value of £5,300,000 ($25,792,500). In this amount the shipments which found their way to South Africa by Portuguese harbors on the east coast were not included.

"Compared with the previous year, this means an increase of exports amounting to 36.8 per cent. A considerable part of these consists, however, of agricultural products (breadstuffs and live animals), in which Great Britain does not enter as a competitor; they do not amount to quite one-third of the total exports. More than two-thirds (£3,792,259 = $18,455,028) of the total exports are wares in which America appears as a competitor of England in the South African markets.

"During the fiscal year 1901-2 this part alone of the American exports to South Africa increased 29.4 per cent compared with the previous year.

"The following figures show the classes of goods in which American competition is especially dangerous to England.

"Compared with the previous year, American exports increased as follows:

Iron goods	£108,538	$527,237
Machinery, including plows, other agricultural implements, and typewriters	42,000	204,393
Household goods	22,719	110,562
Boots and shoes	18,483	89,947
Textile	12,500	61,831

"The preferential tariff on British goods to Canada was viewed with indifference by America, as it was believed that American trade in Canada could not be arrested by the preferential tariff. With South Africa, however, far distant from the United States, the case is entirely different. The tariff treatment of American imports there is of more weight for America than in Canada."—Richard Guenther, Consul-General at Frankfort.

Print Goods in South Africa.—In these days of severe trade competition, especially for the South African market, the following opinion of a celebrated expert on the subject of printed cotton goods, especially that class called *Deutsche blandruck*, must, I think, be of special interest to our American manufacturers, who seem to want to capture their share of that trade:

"In examining these cloths it is impossible not to notice the discernment of the foreign manufacturer in the way he makes preparations to supply an article widely used. He goes out and ascertains on the spot the requirements of the community, observing carefully and without haste. He studies their habits and customs; watches them at their work and at their games. He notes the effect of sun, rain, and dust on their dress, and the appearance of their clothes after they have been washed a few times. In a word, he learns by observation and inquiry what these people want, and when he has gathered all the information necessary he comes home and makes the things to fit them.

"What does the foreign manufacturer learn from this?

"He learns, first, that the great bulk of the Boer women work either in the homestead, the field, or the dairy and that they need something strong, from which the mud stains or grease spots can be washed. He learns that neither sun nor rain must affect the color; that the pattern on the cloth must be neat and pleasing to the eye; that it must not be liable to disappear the first time the garment is washed in any kind of water. He makes a cotton cloth so heavy and strong that it will wear well and wash well; he dyes it with pure indigo, that it may withstand the action of the powerful sun; he prints upon it a neat and pleasing pattern in such a way that no amount of washing can remove it or spoil the effect. He then offers it for sale in qualities, widths, and prices to suit every one."—Oliver J. D. Hughes, Consul-General at Coburg.

British Consular Notes on Danish Trade.—The following notes are taken from a report of the British Consul at Copenhagen to his Government:

Electric Tramways.—The cars for the extensive system of tramways in Copenhagen have been, up to the present, built in Germany and in Denmark; also the electric plant. The value of the supplies runs into many thousands of pounds.

Sporting Requisites in Denmark.—The attention of British manufacturers is called to the rising popularity of athletic sports in Denmark. The trade in sporting articles is growing and the demand for athletic goods is increasing. Hitherto the sale of these goods has been entirely in the hands of British manufacturers or exporters.

Haberdashery.—Almost the whole of the haberdashery trade is in the hands of the Germans, and travelers from the United Kingdom are few and far between. The best way to introduce this class of trade is to send an experienced traveler to find out the local requirements, and, if necessary, appoint a reliable agent, always being careful to quote prices and give particulars in Danish.

Wall Paper.—There is also considered to be a very good opening for the introduction of wall paper into the Danish market, and a good and profitable trade might be worked up. Building is still on the increase, and the consul states that he can not remember ever having heard of a traveler for these goods coming to Copenhagen.

California Wines.—Commenting on an attempt being made to introduce California wines on the Danish market, the consul says:

"From all accounts the prices asked are somewhat too high. It remains to be seen how far it is possible to popularize them in a country in which excellent beer is sold for 1s. 2d. (28 cents) per dozen bottles. There is no doubt that this matter is worth looking into."

Mexican Commercial Museums Abroad.—Consul W. W. Canada, of Veracruz, under date of June 8, 1903, says:

The Department of Public Improvement of the Mexican Government has under consideration the advisability of establishing commercial museums in connection with the more important consulates in foreign countries. Through the efforts of the Mexican consul at Liverpool, England, an exposition of the products of Mexico is about to be inaugurated at that place. The governors of the several States have been requested to forward samples of the principal productions of their respective sections. Precious woods, fibers, cereals, vanilla beans, coffee, sugar, etc., are to be sent at once to the consulate at Liverpool.

The Mexican exposition at Milan, Italy, is in complete working order. Its large and commodious rooms are visited daily by merchants and manufacturers, who thus come in direct communication with the Mexican producers.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

SELECTED FORMULÆ.

Perfume for Ballroom Floor Gloss.—

Oil of lavender	½ ounce
Oil of verbena	20 minims
Oil of neroli	20 minims

—Pharm. Era.

Face-Black for Actors.—

Best lamp-black	1 drachm
Cacao butter	3 drachms
Olive oil	3 drachms
Oil of neroli	2 drops

Melt the cacao butter and oil, add the lamp-black, and stir constantly as the mixture cools, adding the perfume toward the end.

Paper Hygrometers.—According to the Druggist's Circular and Chemical Gazette, paper hygrometers are made by saturating white blotting paper with the following liquid and then hanging up to dry:

Cobalt chloride	1 ounce
Sodium chloride	½ ounce
Calcium chloride	75 grains
Acacia	¼ ounce
Water	3 ounces

The amount of moisture in the atmosphere is roughly indicated by the changing color of the papers, as follows:

Rose-red	rain
Pale-red	very moist
Bluish-red	moist
Lavender-blue	nearly dry
Blue	very dry

Oil Polish for Shoes.—

Bone black	10 parts
Molasses	10 parts
Sulphuric acid	5 parts
Sodium hydrate	4 parts
Fish oil	20 parts
Water sufficient.	

Mix the black with the molasses and to it add the acid. Dissolve the soda in a small amount of water, add the oil and boil with constant agitation until the liquid has become homogeneous. When this occurs, add the bone black mixture, a little at a time, under constant stirring, until a smooth paste is obtained, then pour into metal boxes. The consistency of the mass may be varied from that of a paste to that of a syrup by increasing the amount of liquid used in saponification of the oil.—Spatula.

Weather Forecaster.—

1. Cobalt chloride	1	part
Gelatin	10	parts
Water	100	parts
2. Copper chloride	1	part
Gelatin	10	parts
Water	100	parts
3. Cobalt chloride	1	part
Nickel oxide	0.75	part
Gelatin	20	parts
Water	200	parts

These solutions may be painted on the insides of windows, or on calico, and in fine weather No. 1 appears blue, No. 2 yellow, and No. 3 green. When wet weather approaches, the colors disappear.—Pharm. Era.

Poultry Foods.—

1. Powd. egg shell or phosphate of lime	4 ounces
Iron sulphate	4 ounces
Powdered capsicum	4 ounces
Powdered fenugreet	2 ounces
Powdered black pepper	1 ounce
Silver sand	2 ounces
Powdered lentils	6 ounces

A tablespoonful to be mixed with sufficient feed for twenty hens.

2. Oyster shell, ground	5 ounces
Magnesia	1 ounce
Calcium carbonate	3 ounces
Bone, ground	1½ ounces
Mustard bran	1½ ounces
Capsicum	1 ounce
3. Sodium chloride	1 ounce
Iron sulphate	½ ounce
Sodium carbonate	½ ounce
Sulphur	½ ounce
Beef, lean, dried and powdered	10 ounces
Fine sand	10 ounces
Corn meal	20 ounces
Linseed meal	20 ounces

Reduce all to moderately coarse powder and mix well.—Spatula.

Soda Water Sundaes.—

Boston Nut Sundae.

One dipper of ice cream, sliced orange cut in diamond-shaped pieces, sliced pineapple cut in triangular shape, whole English walnuts, maraschino cherries. The nuts and fruits to be arranged artistically. No syrups used.

Caramel Nut Sandae.

Mix equal parts of pecans, English and black walnuts, pignolia and pistacio nuts. Chop together and mix with an extra heavy caramel syrup over plain ice cream and you have a delicious sundae.

Chocolate Fruit Sundae.

Strawberry syrup, 10 ounces; vanilla syrup, 10 ounces; raspberry syrup, 8 ounces; chocolate syrup, 4 ounces. Pour a ladle of this sauce over plain ice cream.

Mint Sundae.

Pour over ice cream one ladle of rich mint syrup and decorate with two sprigs of mint and a blanched almond.

Central Sundae.

Two pounds English walnuts, two pounds pecans chopped together with one-half pound of powdered sugar; add enough simple syrup to suit taste.

Oriental Sundae.

Equal parts of seedless raisins, currants and English walnuts.—Pharmaceutical Era.

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